ULY, 1948 TECHNOLOGY DEPARTMENT TWO SHILLINGS

Plastics

DEALING WITH THE MANUFACTURE, USES AND POTENTIALITIES OF PLASTIC MATERIALS

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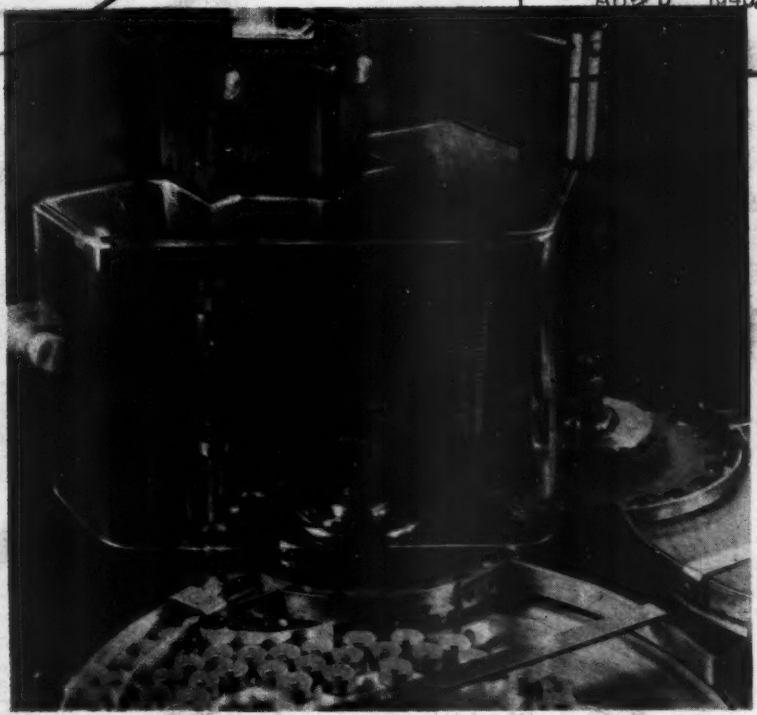

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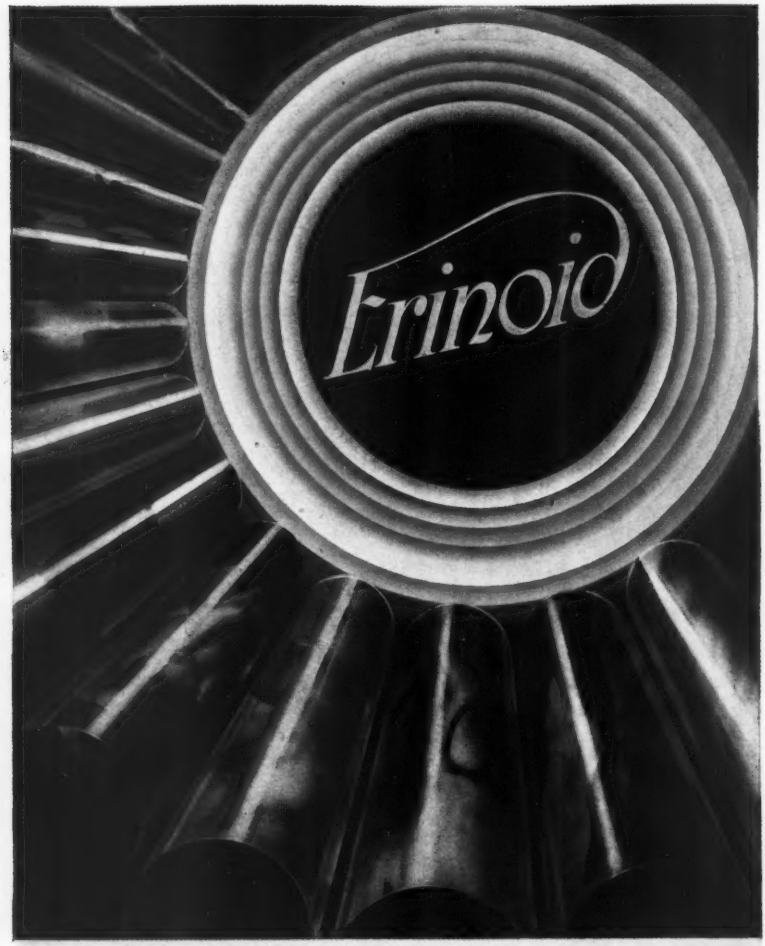

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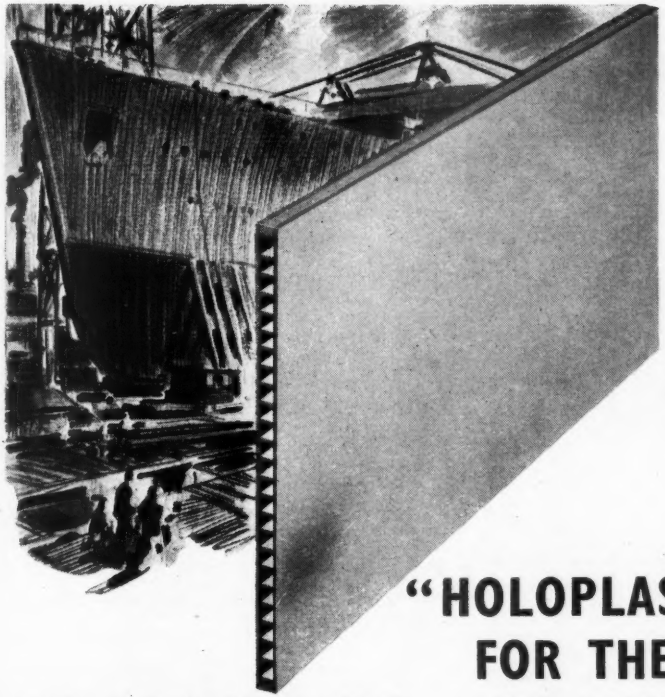

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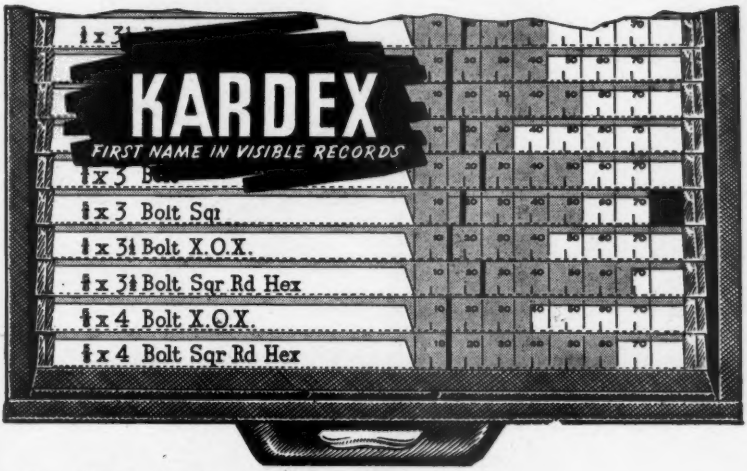

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North-Midland	Castle Gate House, Castle Gate, Nottingham	Nottingham 46216
Eastern	Shaftesbury Road, Brooklands Avenue, Cambridge	Cambridge 56268
London	Mill House, 87/89, Shaftesbury Avenue, W.1	Gerrard 9700
South-Eastern	95, High Street, Rochester	Chatham 3487
Southern	Whiteknights, Earley, Reading	Reading 61491
Wales	27, Newport Road, Cardiff	Cardiff 9234
South-Western	12/14, Apsley Road, Clifton, Bristol, 8	Bristol 38223
Midland	Temporary Office Buildings, Hagley Road West, Birmingham, 17	Bearwood 3071
North-Western	Burton Road, West Didsbury, Manchester, 20	Didsbury 5180-4
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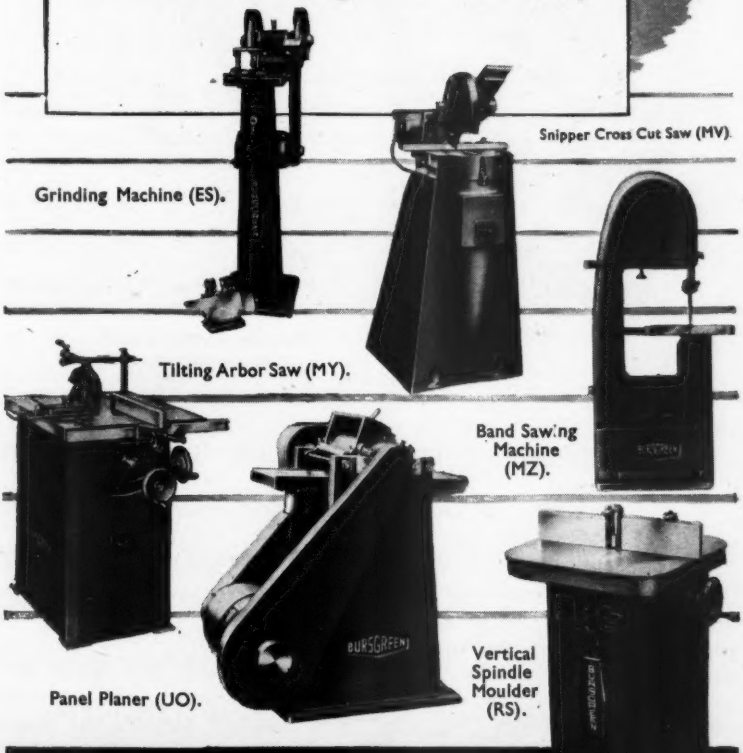

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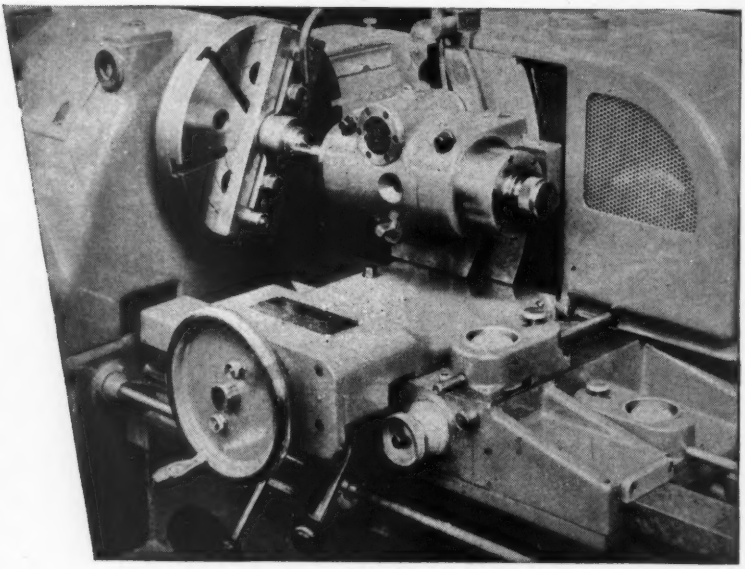

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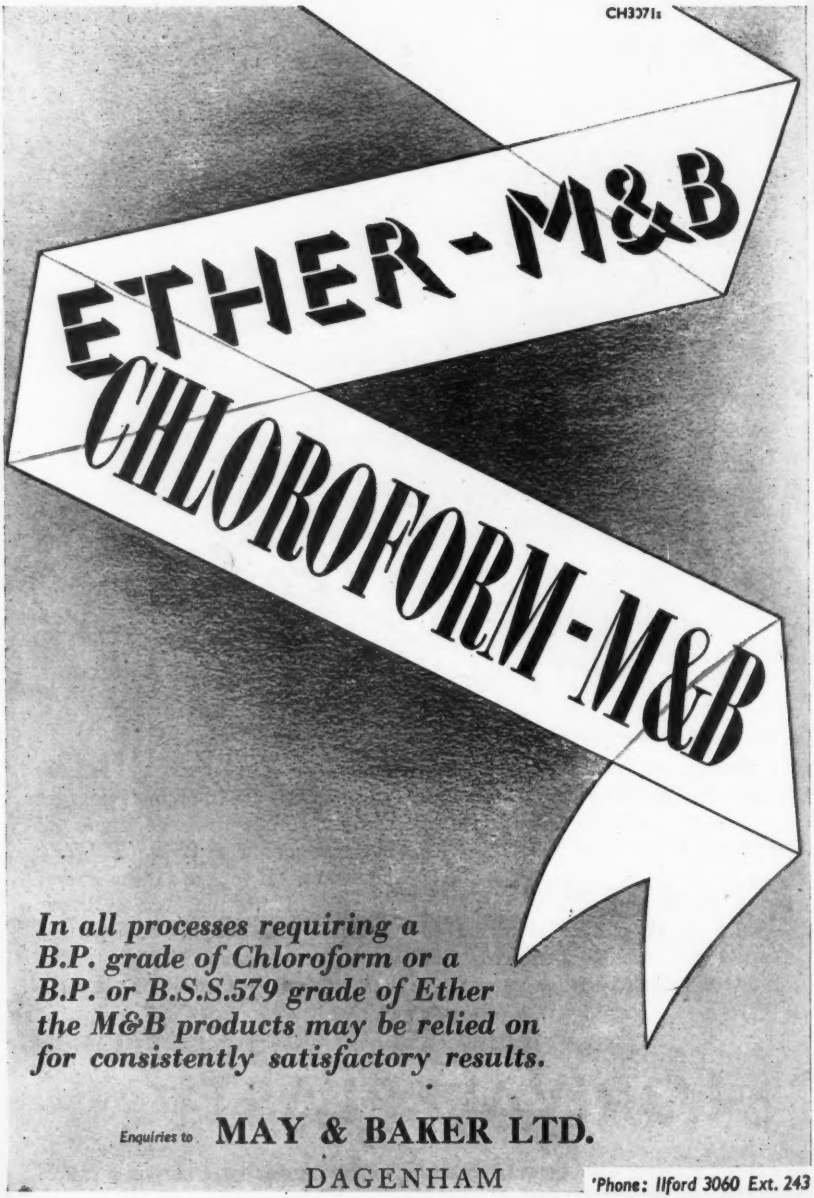
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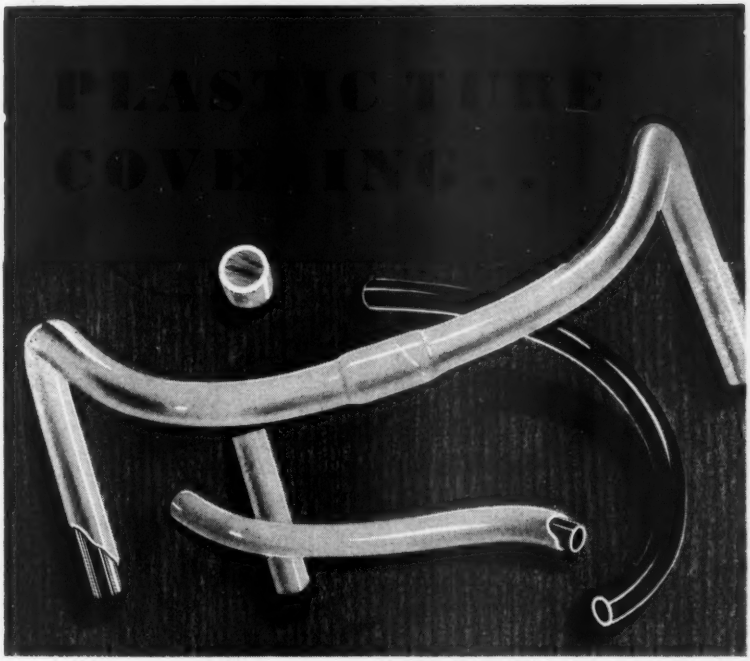

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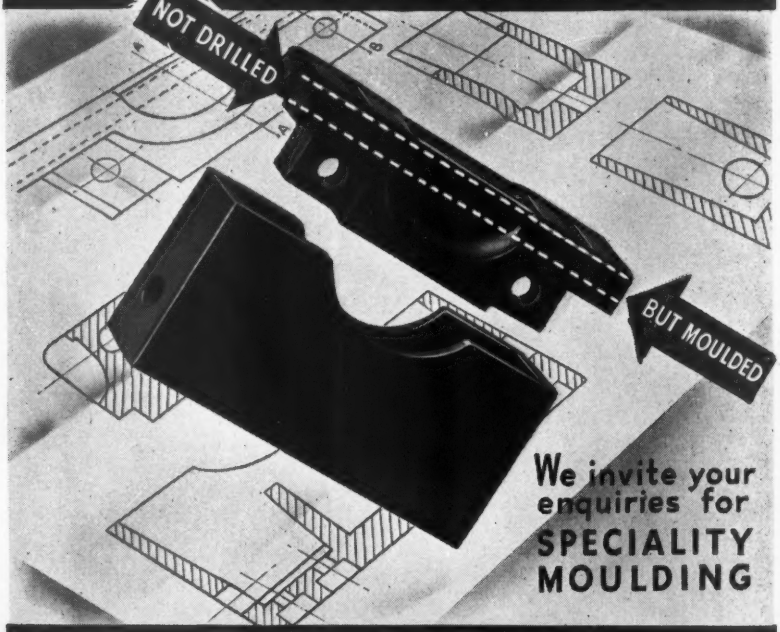

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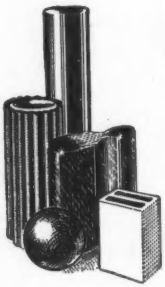

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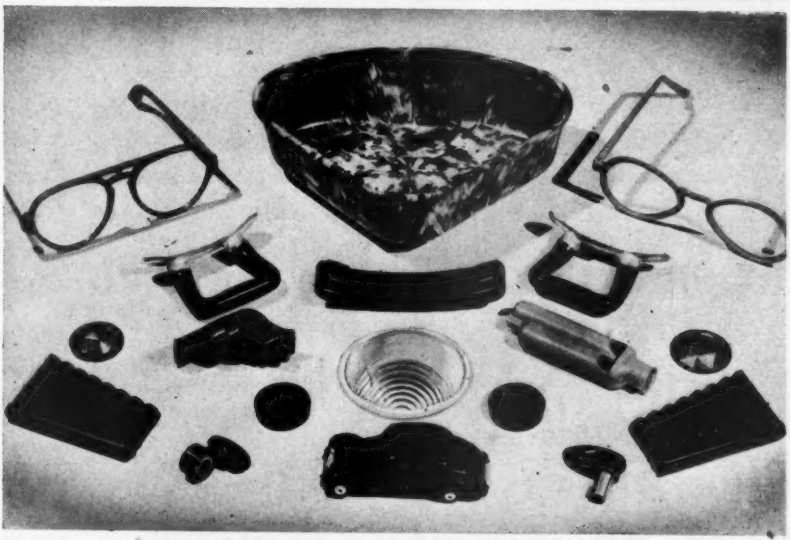

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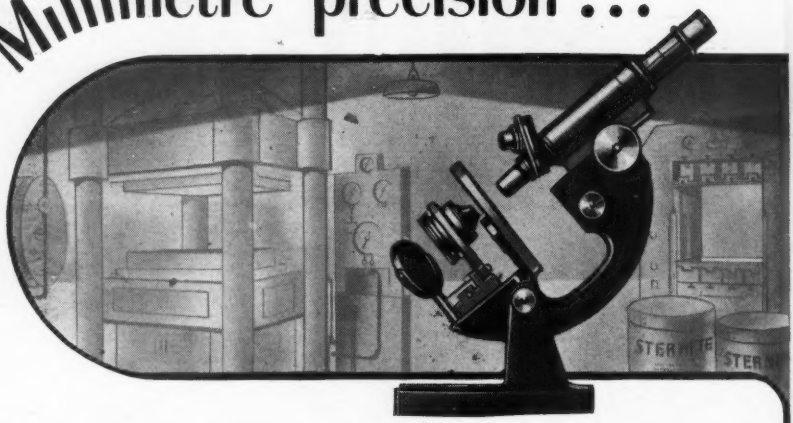

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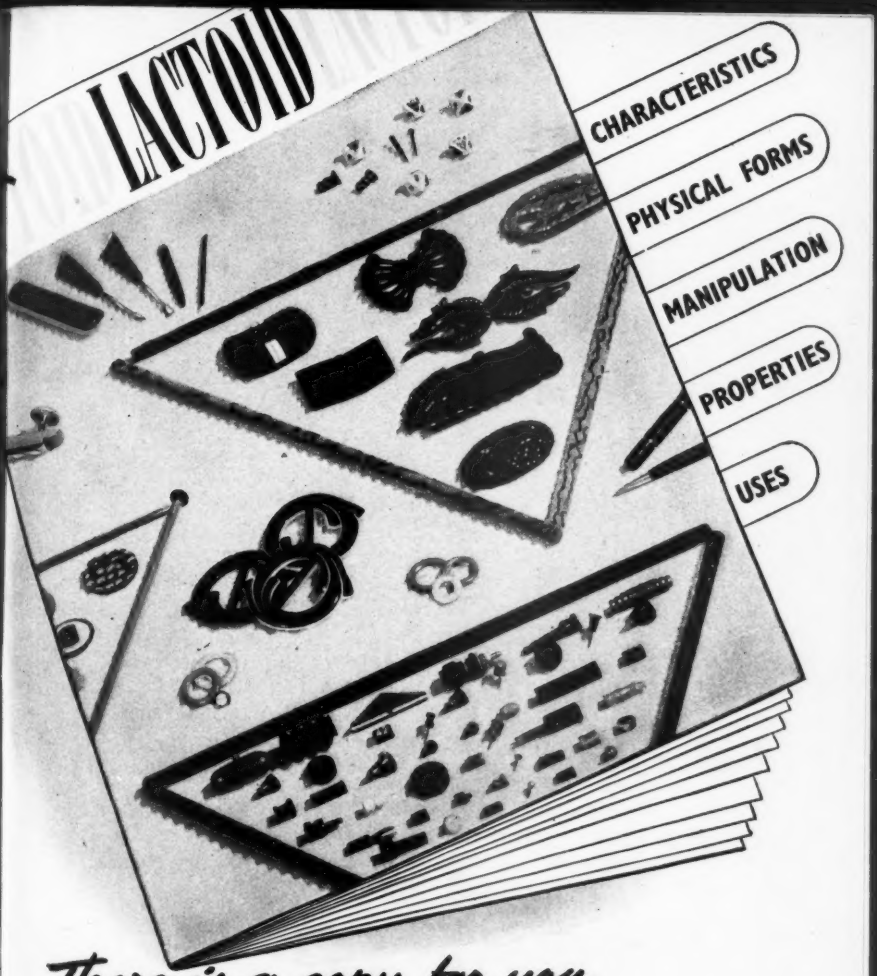

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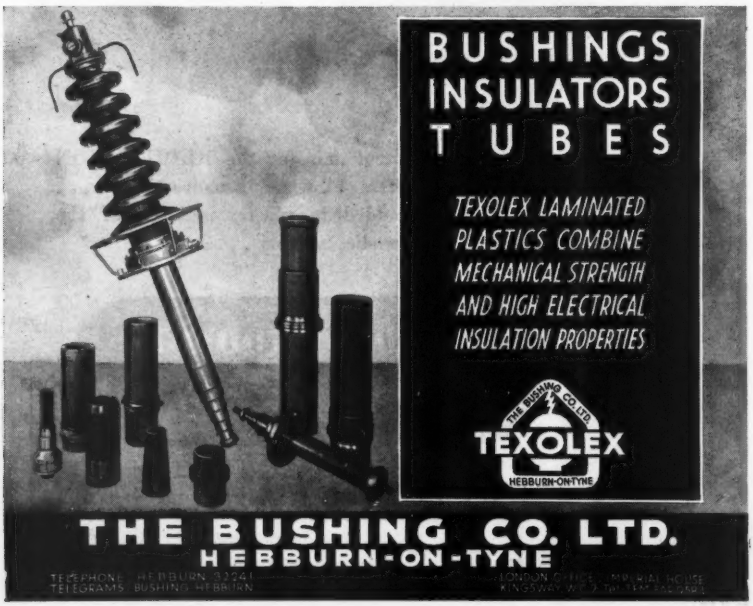

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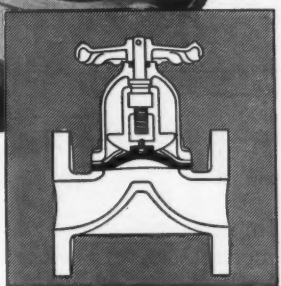

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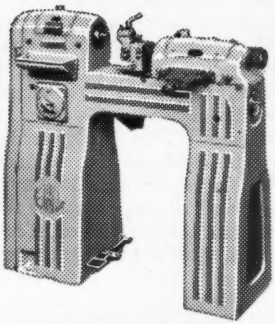

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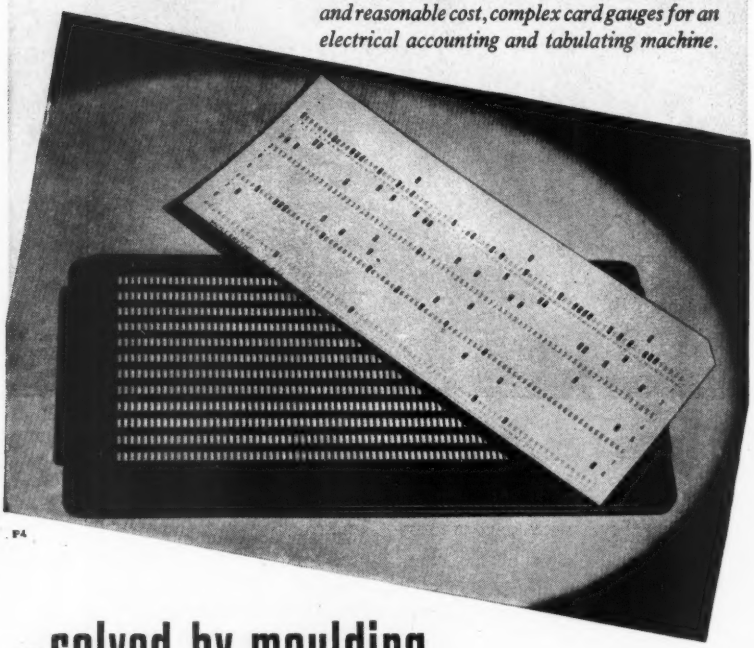

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Vol. XII. No. 134 JULY, 1948

Plastics

Dealing with the Manufacture, Uses and Potentialities of Plastic Materials

Proprietors - - **TEMPLE PRESS LIMITED**
Chairman and Managing Director **ROLAND E. DANGERFIELD**

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NOTICES

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EDITORIALS

Plastics in Orthopædics

ABOUT ten years ago we first saw a small splint made from transparent plastic sheet. It had been fashioned and finished in a very simple manner, but its usefulness was obvious for the purpose—in this instance a replacement of an arm plaster-cast. It was so much less cumbersome and very light in weight. But since the layman is so ignorant of the problems of the surgeon or of the hospital in general, it was difficult to see beyond this and analogous applications of somewhat smaller and larger sizes.

Since those days, however, we have noted in the pages of this journal several advances in the application of plastics in orthopædics in the United States, Germany and in this country ; but its import has been fully brought home to us by a recent visit to the Royal National Orthopædic Hospital at Stanmore, where a special plastics section has been at work for some few years. Some of the results achieved there are described on pages 347-355.

The story has progressed far beyond the simple, small splint, as will be seen, since the whole field of structural deformation of the human body is being tackled, whether that deformation is due to fracture, loss of limbs or the many forms of local and general paralysis.

The very nature of this work (since by far the greater proportion of splints and other forms must, or should, be made to the individual patient's requirements) is not one that readily appeals to the normal industrial fabricating concern. Thus this hospital makes much for its own needs, while there has also grown up a considerable production by certain surgical instrument makers who are now specializing in this field.

It is especially noteworthy that the range of plastics employed has increased considerably, and as is described in the pages indicated, much help has been given to this valuable work by various concerns, not only with plastic raw material, but also with certain pieces of plant wherewith to work it.

We also describe what are generally considered the chemical and physical advantages of plastics over the older forms of splint construction materials—with one omission. The beneficial psychological effect of wearing (in the case of transparent sheet) an almost invisible structure is most striking.

There will, we hope, grow up a very close collaboration between the plastics industry and the hospitals, not only in the spread of knowledge of the newer materials but also in the technique of their working, for the hospitals need this type of help as well as financial aid.

How far the plastics industry may be involved in this comparatively new application is hinted at in the recent announcement by Mr. Buchanan, Minister of Pensions, that new arrangements had been made for providing the disabled with artificial limbs. If the patient under the National Health Service requires one he can obtain it free of charge if of one type or at low cost if it is of a special type. The Ministry, it appears, is interesting itself very closely in these matters from the point of view of maintaining and helping production and of providing adequate surgical supervision in the fitting of the limbs.

Plastic Research at Teddington

WE have often lamented the fact that there is a paucity of high-polymer and synthetic-resin research in this country, and a still greater paucity of published knowledge. How far we are behind the United States in this respect (we refer only, of course, to the quantity and breadth of

research) is common knowledge. In the United States there have grown up what we used to call " schools " under famous professors each developing their own pet theories and practices, training others to follow in their footsteps and to carry on the good work.

Here the number of such " schools " is negligible, and in a sense has been decreased by one since Professor E. K. Rideal left Cambridge as Professor of Colloid Chemistry and went to the Royal Institution. There is, however, a strong team working on high polymers as they concern the textile industry. We know of no other.

We have been reminded of this by the receipt of the Report of the Chemistry Research Board for the period January 1938-December, 1946. Our regret at seeing this so tardily published is tempered by the knowledge that nothing was printed during the war, for obvious reasons, and that most of the work was undoubtedly on the secret list. Much of this will be published separately.

In the main, the industrial researches carried out by the Chemical Research Laboratory at Teddington are usually those considered of basic importance, and therefore constitute long-range problems. As an example which has become " classical " we may recall the original work of Adams, Holmes and Morgan on base-exchange synthetic resins, which has led to world-wide development for the purification of waters. Research on this subject still continues.

In the present publication there is a special section under " High Polymers and Plastics " from which we learn that a new problem has been approached. This entails the study of certain special chemical groupings in the molecule to obtain information regarding the structure of the very large molecules which make up all plastics, and of new means of making high polymers of special structure. In addition the reactions of various compounds with polyvinyl-chloride is being examined.

Obviously during the war much examination of laminates and synthetic glues was carried out for the Ministries. This lead to a considerable understanding of the relationships existing between the mechanical properties of laminated products and the properties of their components on the one hand and on the other to work of considerable value in understanding and developing new types of glues.

This has also led to a study of the polyhydric phenols, such as resorcinol, and the glues made from it, and during 1944-45 a cold-setting resorcinol-formaldehyde glue, S.R.38, was developed at the Laboratory, with a prolonged shelf life and a neutral setting, while the pot can be cleaned out with water. In order to obtain cheaper glues, other polyhydric phenols are being examined.

Concurrently with this work, there has been considerable long-term research in the use of compounds in coal-tar that have not yet found considerable use in industry. Among these is one to which we have already referred in these pages, namely to the removal of hydrogen from acenaphthene to produce acenaphthylene. This latter compound can be polymerized or copolymerized to produce plastics which may yet be of industrial importance. Copolymers with styrene and other monomers have also been made with high stability to heat, high softening temperatures and good electrical properties.

The progress attained in the United States in the production of the important silicone resins, " organic " types in which silicon partly replaces carbon in the molecule resulting in heat-resisting compounds, elastomers, impregnating compositions, special greases and anti-foaming liquids, etc., has set in hand a series of researches at the Chemical Research Laboratory. Since, in the words of the report on this branch, " the formulation of industrially useful materials remains shrouded by an extensive and all-embracing series of patent specifications," it has been considered important to prepare certain intermediates, carry out analyses of commercial silicones and also to prepare the resins and silicones from the intermediates. Some mouldings were also produced from the resins.

Welding Acetate Sheet

WHEN high-frequency welding first assumed importance, some five years ago, it was accepted that cellulose acetate sheet could be treated by such means. In fact only p.v.c. sheet has become of importance in this respect.

One reason lies in the fact that cellulose acetate can be cemented adequately with solvents or other chemicals and that there is naturally resistance, for economic and other reasons, against disturbing what appears an adequate existing organization. Cementing of p.v.c., on the other hand, is far from efficient, so that high frequency welding found rapid entry.

Another and perhaps more important reason lies in the fact that welding of acetate sheet has not always been successful because of different methods of manufacture. Thus successful welding, partial failure and complete failure have all been experienced with different sheets from different sources.

It is good news, therefore, to learn that a close examination of the compositions of acetate sheets has clarified the problem so that high frequency welding may now take its place in this field and replace the rather cumbersome and comparatively slow methods of cementing. We shall have pleasure in publishing details of this advance in our August issue.

Cups and Saucers

OUR remarks on probable greater adoption by housewives of plastic cups and saucers with the growing improvement in quality has brought both agreement and disagreement.

There is entire agreement that quality, by which is often meant among housewives merely the greatly enhanced beauty and "texture," has improved enormously since the war and that we now produce non-staining cups. There is also an acknowledgement that breakages are less, although in the absence of exact examples it is difficult to tell whether this relates equally to the urea, melamine, acrylic and polystyrene types, or to the truly unbreakable polythene type.

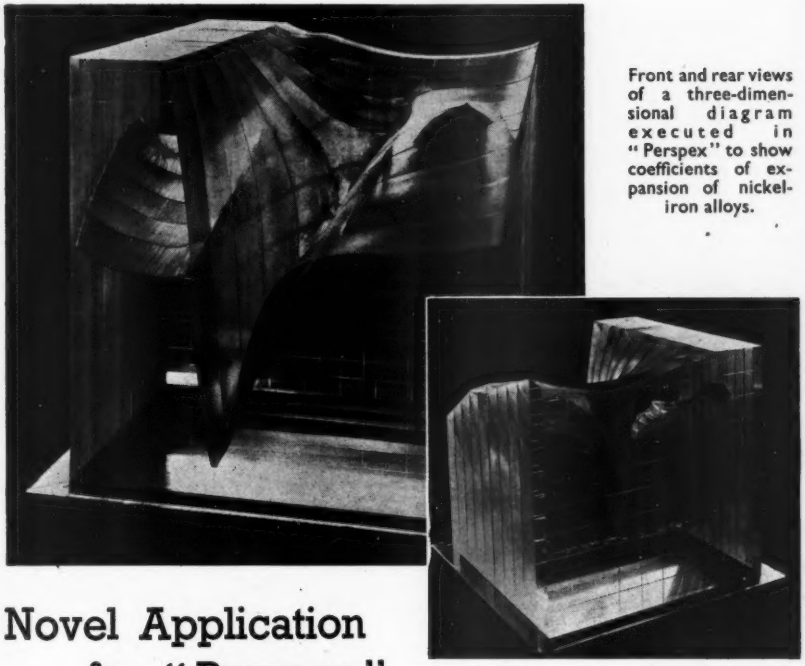
On the other hand, breakages of handles have been especially reported and probably generally refer to the handle that is merely cemented on—a method that cannot be commended.

Violent disagreement was voiced on several occasions because of high price. One buyer, indeed, informed us that 15 shillings was a fantastic price to pay for a cup, saucer and small plate. This price was demanded at large stores in London. To make matters worse, it was quite impossible to buy a single one of these units when it was broken. The set of three had to be bought or not at all. Something certainly seems wrong in the sales set-up here, or there is considerable short-sightedness. What was always available in the "china" industry must be imitated by the plastics manufacturers, especially since the colours do not vary greatly.

We should like to stress more than ever the growing importance of this section of our industry and how much it behoves the moulders to produce the finest qualities only and to realize that cups and saucers, because they are used every day, are under the close and continual scrutiny of every housewife. It will pay to study her requirements and to make it easy for her to buy them.

Birmingham Central Technical College Course in Plastics Technology

Birmingham Central Technical College offers in Session 1948-9 a part-time (day and evening) course leading to the College Associateship (A.C.T.C. (Birm.)) in Plastics Technology. The course also caters for the requirements of students preparing for the City and Guilds Certificate in the Technology of Plastics, and the Diploma and Associateship of the Plastics Institute, and extends over five years for students who have reached Matriculation standard in mathematics, physics and chemistry. Full details are given in the prospectus of the Department of Chemistry, available on request from the Registrar, Central Technical College, Suffolk Street, Birmingham, 1. (Students should enrol in the week commencing Monday, September 6, 1948.)



Front and rear views of a three-dimensional diagram executed in "Perspex" to show coefficients of expansion of nickel-iron alloys.

Novel Application for "Perspex"

VISITORS to Earls Court on the occasion of the 1948 B.I.F. may remember seeing the striking and unusual application for "Perspex," which is here illustrated. It was exhibited on our own "Plastics" stand, by the kind permission of J. Starkie Gardner, Ltd., of Merton Road, Southfields, London, S.W.18, who made it on behalf of The Mond Nickel Co., Ltd. By courtesy of both concerns we now publish these photographs.

Actually, it is a three-dimensional diagram, mathematically proportioned and contoured to show the coefficients of expansion of nickel-iron alloys of various compositions at different temperatures. It is made from a number of thick sheets of "Perspex," which are assembled into the form of a solid block measuring 14¾ ins. by 15¼ ins. at the base. As will be appreciated, some intricate machining was called for, the finished job being no mere curiosity but one which has to assist in scientific investigations with a particular accuracy.

By the aid of concealed lighting full advantage is taken of the refractive properties of the "Perspex," and the significant plane is caused to glow and appear to be supported without visible means across the individual reference grids. When desired, for demonstration purposes, the model can be dismantled, thus simplifying the difficulties of explanation which are normally associated with diagrams of this kind. A black anodized aluminium base accommodates the tubular lamps needed for illumination.

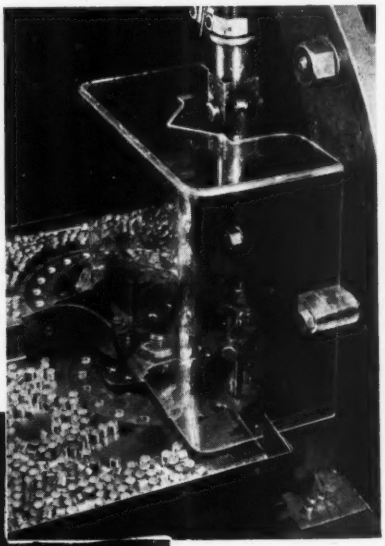
Starkie Gardner are to be congratulated on their achievement in craftsmanship and the effective manner in which they have utilized the properties of the transparent acrylic resin.

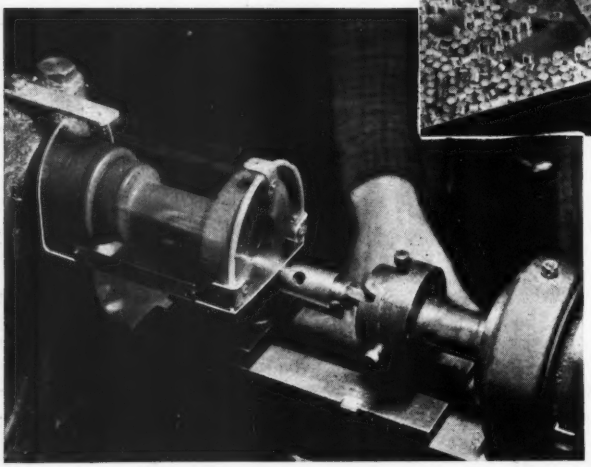
Acrylic Sheet as an Aid to Safety

THE logical solution for giving protection against the hazards of moving machinery is found in adequately fencing or guarding the parts which are likely to cause personal injury. For instance, stout wire mesh or light expanded metal is commonly employed for the construction of cages, within which power transmission belts do their particular job with virtually 100 per cent. freedom from accident.

Reference to any recognized code of industrial safety rules will show that much emphasis is laid upon the risks attending the "unguarded" moving parts of a machine. For each type of machine and, indeed, for particular situations in which machinery is installed, there are approved methods of providing protection for the operator and likewise to others who may have cause to pass within hazardous distance. Lathes of the rotating-knife type, such as those employed for making shoe-lasts, and spokes in the wood-working industry, have to be equipped with hoods or covers which completely enclose the cutter blades while the stock is being worked. The cutters on almost every milling machine in the metal-working industry require a guard which provides positive protection for the operator's hands.

In every industry where machinery is commonly employed there are situations which demand guards for certain moving parts. With regard to some of these situations, it is not always an easy matter to provide for safety without visually hindering the operator in his duty of attending the machine;





(Above) "Perspex" guard as used on Eley iron and brass head assembling machine.

(Left) Another example of the use of "Perspex" for machine guards.

Bench drilling machine with "Cleervue" guard as made from "Perspex" by the Silvaflame Co., Ltd.

eye and hand invariably work together. We find this to be particularly so in the case of lathes, and milling and drilling machines; also for assembling mechanism of the press-tool type. The illustrations which we publish on these pages show certain situations where acrylic resin sheet can offer important advantages as a constructional material for machine guards, screens and other protective devices.

The clear acrylic resin provides complete visibility of the moving parts, and also freedom from shadow. Such a guard is less cumbersome than one made of any other material; it may be fitted very close to the moving parts, and there gives additional protection against the accumulation of dust, grit, etc., from external sources. Moreover, there is here a factor of psychological importance —it is common experience that a machine fitted with a transparent guard can be operated with greater confidence, for then the operator is not bound to work "at arm's length" from the machine, but has a close view of the job simultaneously with full protection from injury.

Fabricated from "Perspex" sheet, such machine guards do not show any tendency to turn "yellow" with age when in their industrial situation. The cutting and shaping of the acrylic sheet is carried out quite simply and without the need of expensive equipment.

Illustrations accompanying this article are by courtesy of I.C.I. Plastics Division and the Silvaflame Co., Ltd., 218a Monument Road, Birmingham, 16.

GAUGE AND TOOL MAKERS' ASSOCIATION.—Mr. F. W. Halliwell, chairman and managing director of Gay's (Hampton), Ltd., has been re-elected president of the Association for 1948-49; Mr. H. S. Holden, managing director of The Brooke Tool Manufacturing Co., Ltd., has been re-elected chairman; Mr. A. L. Dennison, chairman of The Birmingham Tool and Gauge Co., Ltd., vice-chairman; Mr. R. Kirchner, director of Arnott and Harrison, Ltd., hon. treasurer; Mr. H. H. Harley, chairman of The Coventry Gauge and Tool Co., Ltd., continues as immediate-past-president.

PLASTICS IN GERMANY

The New Target in Germany is the Science behind the Industries. The following are additional Notes from the Official Reports which can be obtained from H.M. Stationery Office.

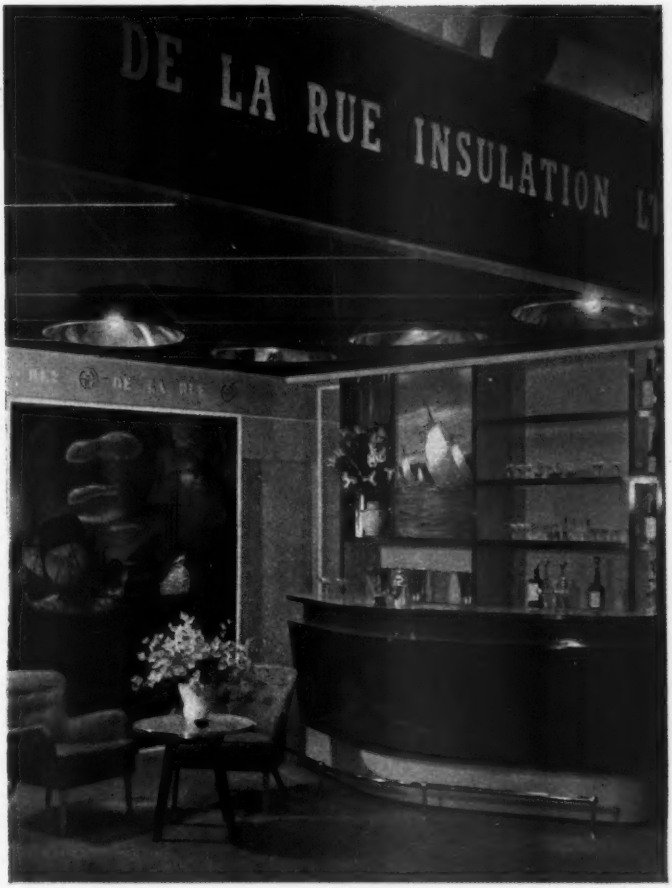
B.I.O.S. Final Report 1478.—Available information on the polymerization of vinylidene chloride and the extent of the development of polymers based on this material is gathered together in this report. At Ludwigshafen, the production of a copolymer (Diurit) containing about 85 per cent. vinylidene chloride, 13 per cent. vinyl chloride, and 2 per cent. acrylonitrile had reached plant scale, and the product was used extensively for the manufacture of bristles. The main difficulty was the inability to produce a polymer which was sufficiently heat stable to allow manipulation at 170 degrees C., but this was finally achieved by an elaborate purification of the monomer and a scrupulous removal of all traces of iron from all the chemical materials used in the process. The manufacture of this grade of polymer is described in detail. A copolymer containing 92.5 per cent. vinylidene chloride and 7.5 per cent. ethyl acrylate has been developed for the production of fine thread by spinning from a 25 per cent. solution in tetrahydrofuran, and this was manufactured by the same process as for Diurit.

B.I.O.S. Final Report 1497.—The subject of this report is polyurethanes; the information given is intended to supplement that of C.I.O.S. Report XXIX-12. Concerning polyurethane lacquers, it is stated that there is no satisfactory stabilizer to prevent gelling. These products are used in tin coating and in paper treatment. The tin coatings showed better acid resistance than did conventional materials, but were not proof against acetic acid. The wet strength of paper coated with the lacquers was much better than that of paper treated with ordinary resins, a coating of 18 grams per sq. m. being sufficient. Paper coated with polyurethane compared in impermeability with Pliofilm and metal-coated papers. A note is included on the use of the polyester Desmophen for the production of foam masses.

B.I.O.S. Final Report 1498.—Work on the polyurethanes and related synthetic resins was started by the I.G. in 1937. This report is based on information provided by Prof. Otto Bayer, of I.G. Leverkusen, who merely outlines the reactions concerned with little actual detail of the processes. Some notes on properties and uses, however, are included. The ordinary "hard" polyurethane resins with mol. wt. in the region of 10,000, had properties similar to those of the nylons, but, generally speaking, were somewhat harder, more resistant to acids and alkalis, had lower moisture absorption, and better electrical insulation properties. For injection moulding, they were better than nylon as there was lower contraction on cooling. Unlike nylon, the polyurethanes could be made at room temperature in ordinary vessels, without necessity of pressure or vacuum. Simple cross-linked types, e.g., the Polystals, were used extensively as adhesives for plywood and for paper and fabric lamination, the two reactants being mixed on the surface of the material. Since there was no liberation of moisture or of any gases during interaction they had advantages over phenol-formaldehyde and urea-formaldehyde resins in this application; in contrast to "cold-setting" adhesives of the latter type, the polyurethanes did not require any acid catalyst.

B.I.O.S. Final Report 1582.—Resins made by the action of formaldehyde on aniline have been mentioned in C.I.O.S. XXIX 62 (p. 90), B.I.O.S. 861 (p. 348), and B.I.O.S. 1065 (p. 131). The present report amplifies the details already published, especially as regards preparation. The resin "Iganil" is not versatile, and in Germany it was used without filler as moulding powder; with a cellulose filler also as moulding powder ("Cibanite") or when sheeted, as laminating paper. Properties of mouldings are tabulated. The main use for Iganil is in electrical switchboards, the laminated board being 1 cm. thick. The unfilled resin is employed in high frequency work because of its low dielectric constant and loss factor.

B.I.O.S. Final Report 1740.—This report relates to cellulose acetate, cellulose tripropionate, and cellulose acetate-butyrate, the information therein being that obtained by the interrogation of technicians from I. G. Dermagen. Regarding raw materials, wood pulp gives the more uniform product; that from linters is often not true to sample. Wood pulp, however, does not give as good quality as does linters; for the latter the yield is also 1 to 3 per cent. better.



The "Yacht Club" bar at the B.I.F. stand of De La Rue Insulation, Ltd., whose "Formica" and "Traffolyte" decorative laminated plastics have been used as constructional materials. The bar has been built by Gaskell and Chambers (London), Ltd., to the design of Clive Entwistle. "Cigarette-proof" grey "Formica" was used for horizontal surfaces. The murals, painted by R. A. Walker, were of "Traffolyte."

This beautifully worked crucifix set has been fabricated from Catalin cast resin. The figure of The Christ has been delicately finished by hand.

Makers : Marberry Products, Ltd. Hurstpierpoint, Sussex.

World's Industry Employs Plastics

GENERAL ENGINEERING

Stress Testing. — A. G. Ward and R. R. Marriott have designed a constant stress extension apparatus for measuring extension-time curves for plastics, for which a Poisson's ratio of 0.5 can be assumed. Extension up to 50 per cent. can be measured. The constant stress is obtained through a cam. Preliminary results of the behaviour of a nitro cellulose plastic are given. (" J. Sci. Instruments," 1948/May/147.)

Nylon-reinforced V-belt (A.S. Rubber Co., Rockfeller Centre, New York) is said to have twice the strength of conventional V-belts. (" Business Week," 1948/Apr. 17/78.)

Threaded Components.—A mould for the production of threaded components, which are subsequently freed automatically during the opening of the mould, is described in " Machine Shop Magazine," 1948/May/86. It was designed by D. and H. Designers, Ltd., for Rolls Pens, Ltd., the mould being made by Universal Tools, Ltd., Mitcham.

New injection head on plastic moulding machine by Lester-Phoenix Inc., Cleveland, Ohio, has independent temperature control in its spreader and a completely annular material passage. Maintenance costs are said to be reduced, and production increased. ("Machinery," New York, 1948/Feb./200.)

Laminates.—J. J. Lamb and B. M. Axilrod report on tensile stress-strain relationships of laminates for small strain. Data were taken on six representative laminates for the first 0.5 per cent. strain. Glass-fabric polyester, asbestos-fabric, high-strength paper, and cotton-fabric phenolic laminates were tested. An empirical parabolic expression for the tensile stress-strain curves was found fitting. (A.S.T.M. Bulletin, 1948/Mar./59.)

Injection Moulding.—New horizontal injection-moulding machine (Hydraulic Press Mfg. Co., Mt. Gilead, Ohio) is able to mould 40 oz. of acetate or 32 oz. of polystyrene per cycle. It handles all types of thermoplastic material. The machine is quick in operation and moulds are quickly changed. (" Business Week," 1948/Apr. 3/52.)

MISCELLANEOUS

Buried cables sometimes need additional protection. Bell Telephone Laboratories have developed a rubber thermoplastic compound in strip form which can be wrapped around the cable lead sheath and does not require vulcanization. (" Bell Laboratories Record," 1948/Apr./148.)

Research problems in relation to plastics have been surveyed by the American Society for Testing Materials. The problems are sub-divided into six groups: (a) Behaviour of plastics under mechanical stress, with time and temperature as variables (stress v. strain relationships); (b) studies of wear abrasion, scratch or mar resistance (study of energy required to scratch, indent, abrade, etc.); (c) permanence of plastics in various environments, with the object of learning what chemical and physical changes occur; (d) compilation of data not yet available (e.g., thermal conduc-

tivity of plastics solid and "foam" types); (e) studies of methods for characterizing the chemical and physical structure of plastics; (f) development of methods for evaluating coated fabrics; (g) development of rapid-test methods, the results of which could be qualitatively related to A.S.T.M. standard-test methods. (A.S.T.M. Bulletin, 1948/Jan. 13.)

Viscosity of Plastics.—F. E. Piech and W. E. Gloor report investigations on the use of the Rossi Peakes flow tester (also known as the Bakelite-Olsen tester) in measuring the apparent viscosity of plastics at temperatures from 115-175 degrees C. (A.S.T.M. Bulletin, 1948/Mar./70.)

Optical Material.—H. R. Moulton surveys the use of plastics as optical material. He discusses optical requirements, methods, optical properties, and their future possibilities, which are said to be unlimited. (A.S.T.M. Bulletin, 1948/Mar./75.)

Balloons.—The Aeronautical Research Laboratories, of General Mills, Inc., have developed a giant plastic balloon, capable of reaching altitudes above 100,000 ft. with a payload of 70 lb. The thin plastic film permits the balloon to float in air only 1 per cent. as dense as air at sea level. The balloon is to be used for exploring the upper regions of the stratosphere. ("Machinery," N.Y., 1948/Apr./167.)

Protective Coatings.—In a review of protective organic coatings, L. A. Critchfield also discusses many modern synthetics. Polymerization may be obtained during the formation of the film or before dissolving the resin. ("Products Finishing," 1948/Mar./30.)

Non-inflammable sponge rubber (Commonwealth Engineering Co., Dayton, Ohio) can be cast in sheets or open moulds. In sheet form it can be produced in a similar way as paper. The product can be vulcanized to upholstery or to fireboard (for lining cartons). It is said to be odourless, tough and highly resilient. ("Business Week," 1948/Apr. 17/74.)

Curing of phenolic resin baked coatings on metal by induction heating offers many interesting possibilities, according to work carried out in the New York laboratories of Bakelite Corporation. ("Products Finishing," 1948/Apr./74.)

Chlorinated synthetic rubber is particularly adapted for the manufacture of industrial maintenance paints and quick-drying enamels. They are finding increasing use under corrosive conditions. ("Products Finishing," 1948/Apr./86.)

Synthetic fibres.—R. Bouvet, of the American Viscose Corporation, gives a survey of the application of synthetic fibres in the textile industry, including fibreglas, nylon, vinyon, saran-velon-permalon, polyethylene, etc. (A.S.T.M. Bulletin, 1948/Jan. 20.)

Moulds.—T. A. Dickinson discusses the requirements and problems of metal moulds for plastics. He stresses, in particular, how to make test castings to obtain satisfactory production parts. The article closes with twenty rules for proper mould design, as issued by the Boonton Molding Co., to which the author adds other recommendations. ("Tool Engineer," 1948/Mar./27.)

SOURCES OF REFERENCE

We wish to remind readers that the sources of reference from which these pages are compiled are not, in general, retained in this office. We cannot, therefore, undertake to supply such originals. Nevertheless, most of the foreign journals referred to are available in the Patent Office Library (Southampton Buildings, Chancery Lane, W.C.2) and in the Science Library (South Kensington). Photo-duplicated copies of articles may be obtained from the Photostat Dept. of the Patent Office.

Fig. 1.—Posterior shell or " bed " mounted on an adjustable tubular metal frame.

Plastics and Orthopædics

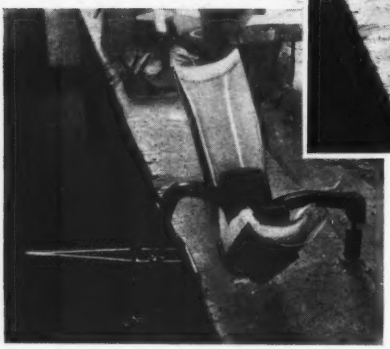
With Special Reference to the Work of the Royal National Orthopædic Hospital at Stanmore, Middlesex

IT is fairly certain that what advances have taken place in the spheres of medical and surgical arts have, with few exceptions, been initiated from within, or at least without any very active initiation from the plastics industry. This is not very surprising because of ignorance on the part of the plastics industry, except in very general terms, regarding requirements, as also the conscious realization that hospitals are not customers of high spending power.

It seems a strange commentary on our so-called modern civilization when the powers behind these organizations have to think twice, and even three times, before adopting new materials which have long been accepted in industry because of their special attributes. More especially, it seems a pity, in a sphere where lightness and cleanliness is of such paramount importance, that so little has been done in introducing plastics in the actual construction of hospitals.

It is, however, in the realm of orthopædics that we do see an important acceptance of plastics; and perhaps this is just as well, for it is in the direct alleviation and prevention of pain and deformity that they are here employed.

What is generally known as orthopædics (originally the meaning was confined to the cure of deformities in children) now embraces the treatment of



Figs. 2 and 3.—Stages in the making of small splints by hand pressing or the use of simple devices. Note the quick-acting clamp.

all anomalies in bone structure, muscle dystrophies, etc., whether by accidental fracture or through disease in the young and old.

The place of plastics, therefore, in this field is, in the main, that of replacing plaster casts and many of the old types of cumbersome appliances.

The production of rigid splints and the like from thermoplastic sheet has been carried out for several years and, indeed, some of the original work was described in "Plastics" as long ago as 1937. Since that date advances in application and in the technique of production has been notable in many countries, and certain concerns which specialize in the production of surgical appliances have done much.

Nevertheless, since it does not require much imagination to realize that hospitals, or, rather, the patients within them, do not lend themselves to wholesale application of products of standard sizes, it is far more interesting and instructive to view the work on plastics carried out in the hospitals themselves. Such a one is the Royal National Orthopædic Hospital at Stanmore, Middlesex. Here in the hospital grounds there is a Plastics Research Unit which is investigating the possibilities of many types of plastic materials. One of these activities is the production of individually shaped forms of a very high order of technical merit from plastic sheet. We are indebted to Dr. J. T. Scales, M.R.C.S., L.R.C.P., who is in charge of this work, for permission to view the technique of production and also methods of application in the wards of the hospital.

Generally speaking, many types of plastic structures are useful. Under conditions in a hospital, however, where production so far must be carried out by relatively simple forming, the thermoplastic-sheet type appear most suitable. On the other hand, for special structures much work has been carried out on certain phenolic and other laminates with considerable success, and a preliminary communication about this immediately follows the present article.

The following notes which we have compiled as a result of our visit to Stanmore are confined to the use of thermoplastics. Most of the work on thermoplastics has been carried out on "Perspex" sheet, although, as will be noted later, a vinyl co-polymer and other co-polymers are also producing interesting results.

The advantages of using "Perspex"

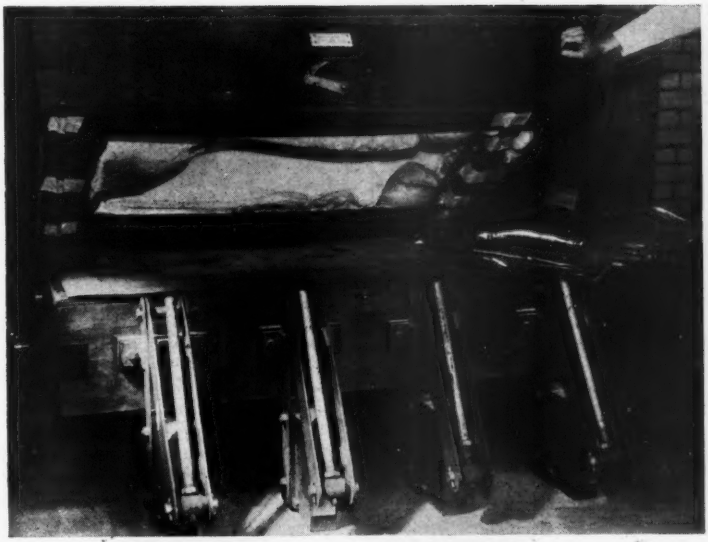


Fig. 4 (above).—For the production of large splints complete air-blowing equipment is employed. The plaster cast is here seen held in the lid of this equipment, and a "Perspex" pressing has just been removed.

Fig. 5 (above).—Top pressure on the plaster cast is maintained by packing with sandbags.

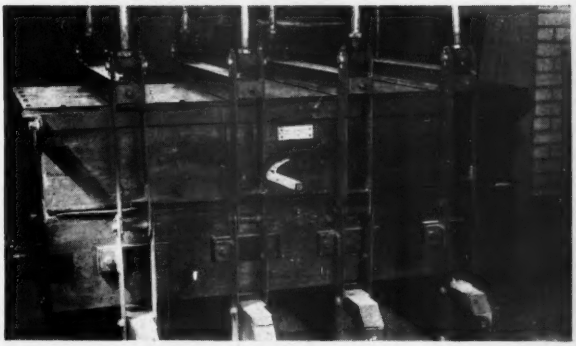


Fig. 6 (right).—Closed and clamped, the equipment is ready for admitting air pressure.

Fig. 7.—Left: Shin piece for artificial limb, made from glass fibre-silicone resin sheet supplied by Ashdowns, Ltd. Centre: Bucket and pylon of "Perspex" for temporary artificial limb. Right: Liner for an artificial limb bucket.

sheet to replace plaster casts are:—

(1) Lightness. We place this first because of the almost intolerable burden a necessarily thick plaster or splint places upon a person already in pain, whereas in this case the patient may frequently move about.

(2) Ease of moulding. The forming can be carried out rapidly, without exceptionally expensive plant. Reclaimability is also important.

(3) Durability and comparatively high strength.

(4) Transparency to light, ultra-violet and X-rays.

(5) Waterproofness and cleanliness. This plastic sheet is unaffected by many substances, including urine, and can readily and easily be washed; the psychological effect of this aspect on the patient is important. Reinfection of wounds is also avoided.

(6) Non-irritation to skin.

In this department of the hospital at Stanmore both small and large splints are shaped, the thickness of the plastic sheet varying from $\frac{1}{16}$ in. to $\frac{3}{16}$ in. In all cases a negative plastic cast is first made.

The heating of the sheet is carried out in small and large modern heating ovens employing infra-red heating (these have been presented to the Plastics Research Unit by the British Thomson-Houston Co., Ltd.).

For small splints, hand pressing with the use of simple devices, as shown in Figs. 2 and 3, is employed. In all cases a plaster cast of the limb is made and the hot, soft "Perspex" sheet is laid on this negative.

For the production of large splints, such as shells and "beds," a complete air-blowing plant (specially designed and presented to the hospital by Triplex Safety Glass Co., Ltd.) is employed (Figs. 4-6). Here the plaster cast is held in the lid of the equipment, top pressure in this section being maintained by packing with sandbags. The base is fitted with a rubber sheet with air inlet-holes, the rubber serving as an air seal and a resin-laminated ("Jabroc") template for edge-strength.

The "Perspex" sheet, which has been heated to the requisite degree of softness (about 135 degrees C.) in the B.T.-H. infra-red heater, is then removed and placed on the rubber sheet in the base of the equipment. The lid containing the cast is closed and clamped, and air pressure at 15 to 20 lb. per sq. in. is then admitted. The plastic sheet is thus forced into the plaster casting, making accurate contact therein. Air pressure is maintained until cooling is complete.

On removal, simple finishing operations are carried out. The shape is

perforated with holes for ventilation, and if, as in the posterior shell or "bed" shown in Fig. 1, it is to be mounted on a tubular metal frame, the flat edge flanges are curved to rest on this support.

With more complicated forms, such as spinal jackets and the appliance known as a Minerva jacket (Fig. 8), we have two separate mouldings, which are slotted and held together with straps. When necessary, as in this case where deep blowing causes thinning of the plastic in the helmet, a reinforcing headpiece may be attached.

Another important appliance which shows important advantages over the plaster type is the temporary "bucket" and "pylon," for use until a permanent artificial limb is ready. As seen from Fig. 7 (centre),

Fig. 8 (above).—The Minerva jacket for spinal treatment showing perforations for ventilation, slots and straps, and reinforcement to headpiece.

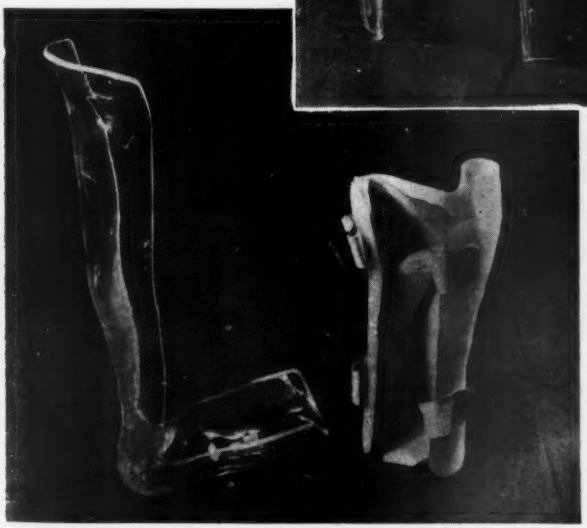


Fig. 9.—Left: Right angle foot splint made from Perspex. Right: Combined wrist and thumb splint made from polythene.

Fig. 10.—Opponens splint for pressing a useless thumb in closer proximity to the forefinger.

there are two parts—the pylon which is produced in a few standard sizes, and the bucket, into which the stump fits, and which obviously must be made for each individual patient.

The plastic appliance is light in weight compared with the plaster type and there is no irritation of the limb, ventilation being provided by air holes drilled in the material. Moreover, there is no deformation in the natural taper of the stump, as so often takes place when the bucket is of plaster. The method of weight-bearing is the same as that in a permanent artificial limb.

Use of Other Polymer Plastics

Obviously the range of plastics available is wide, since all lend themselves to comparatively simple shaping. Thus hard polyvinyl chloride and vinyl chloride-vinyl acetate co-polymer are also used. An interesting application of the latter is in the making of the opponens splint (Fig. 10), a device for pressing a useless thumb in closer proximity to the forefinger. By so doing, writing or other work may be carried out by a person so afflicted. This splint is made from a flat sheet of the co-polymer (supplied by BX Plastics, Ltd.) cut to suitable shape with a template which can be easily varied in size for individual hands. The strip is then shaped by careful heating over a Bunsen flame.

The application of yet another plastic and interesting form is that shown in Fig. 7 (extreme left). This is an artificial limb shaped from glass fibre sheet bonded with silicone resin. Such appliances have been produced in co-operation with Ashdowns, Ltd., of St. Helens. Here we have a structure of exceptional strength which should find many outlets in orthopædic surgery. Its biggest outlet is probably in artificial limb construction. Limbs at present made in this country are produced from aluminium or wood. As pointed out, there are difficulties in the production of plastic artificial limb parts, but these are technicalities which can be solved with financial and industrial help. The plastic shin, for example does not need for its production the elaborate machinery and craftsmanship that is required for metal limb manufacture. In America, where the Government is tackling the problem on a far larger scale, and with more imagination than in this country—£250,000 has recently been allocated for artificial limb development—a "plastic" limb has already been produced, which, although at present is probably no better than the British metal limb, will undoubtedly, with further research, prove to be an improvement with regard to its strength, durability and low cost of production.

Finally, we should like to express our thanks to Dr. Scales for permission to see the moulding shops and for the careful exposition of the plastic appliances made therein.

Much headway has already been made. Many firms have helped with their knowledge and material, among whom I.C.I. may be mentioned, the latter also for financial assistance to the amount of several hundred pounds. As Dr. Scales explained, the field is comparatively new, and given close co-operation with the plastics industry and an infiltration of knowledge regarding every new plastic and the technique of working it, much more may be done to alleviate human suffering.

The Use of "Durestos" for Orthopædic Appliances

By J. T. SCALES,*
M.R.C.S., L.R.C.P.

THE use of plastic materials in orthopædics during the past four years has gradually increased as new materials have become available. As a result of continued experimental work, a number of materials are showing value in the making of orthopædic appliances.† Attention has been directed to the laminates or reinforced plastics in an effort to find a material which could be worked easily but yet have the ideal properties which are required for such appliances. They are not a substitute for those already in use, but are substances which have great advantages and possibilities with regard to their strength-weight ratio, cleanliness, and low cost. It is manifest that no single plastic can be used for all types of orthopædic splints; thermoplastics have their place, as has already been described, but certain laminates offer considerable advantages in ease of manipulation, particularly with larger splints. The strength of such types is the constituent fibres, whether they be cotton, glass, or asbestos. The resin itself possesses but little strength; when acting as a keying agent between the individual fibres, however, it imparts a strength to the finished product far in excess of that of any of the constituents alone.

Although appliances are required in large numbers, each is an individual piece of apparatus which must be made for only one particular patient. Consequently they cannot be mass produced, but rather tailored to each patient's requirements. Most laminates need considerable pressure in order to effect a condensation or curing of the constituents of the resin, as well as to remove voids and air spaces in the laminates.

A new form of laminated material known as "Durestos," composed of asbestos and phenol-formaldehyde resin, has been adapted to splint making. This material is made by Turner Brothers Asbestos Co., Ltd., of Rochdale, Lancs. The asbestos fibres are dispersed in the form of a felt which is treated with phenolic resin as it is being produced. Three standard thicknesses are supplied, but it has been found that the most satis-

Fig. 1.—Cured hip spica of "Durestos," on plaster cast, as removed from curing oven.

* Plastics Research Unit, Institute of Orthopædics (University of London), Royal National Orthopædic Hospital, Stanmore, Middlesex.

† "Plastic Splints and Appliances in Orthopædic Surgery." Woolf Herschell, B.A., M.B., Ch.B., and John T. Scales, M.R.C.S., L.R.C.P. "Journal of Bone and Joint Surgery," British Number, May, 1948. Vol. 30B, No. 2, 298-308.

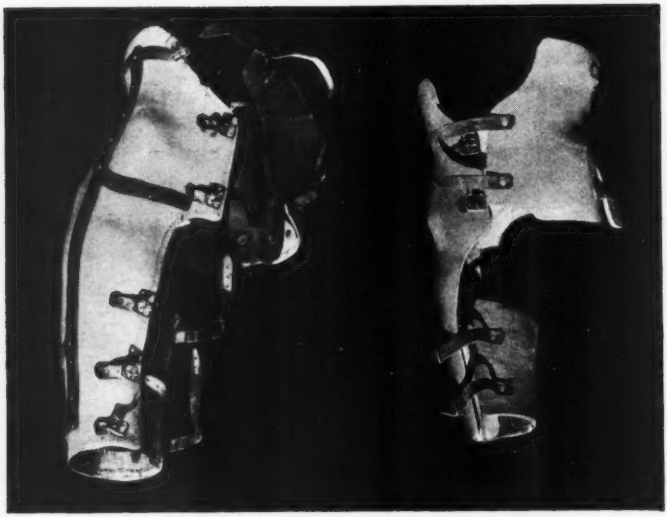


Fig. 2.—Left : Hip spica made from cellulose acetate and reinforced with steel supports. Right : As made from "Durestos."

factory material for our use has been the medium thickness. As supplied by the makers, the sheet felt remains in a pliable condition for about six months, provided it is kept in a cool room.

A plaster cast is taken in the usual manner and a male mould of plaster-of-paris is made as for the production of moulded leather or acetate appliances. The "Durestos" felt is damped with water to increase its flexibility, and it is then applied to the mould which has been treated with a suitable release compound. It is readily moulded to any curve, and in places where added strength is required, an additional layer can be applied. Hand pressure is all that is needed to produce a laminate of sufficient strength for orthopædic requirements, although low-pressure laminating methods can be used if an exceptionally light splint is required.

Usually two or three sheets of the medium thickness material are used. The cast is now placed in an oven, the temperature being kept below 90 degrees C., and allowed to cure for about eight hours (overnight). A further hour's curing at

Fig. 3.—Finished hip spica as made from "Durestos."

140 degrees C. has been found beneficial. After removal from the oven (Fig. 1) the laminate is cut from the cast, and is ready for fitting to the patient. After final adjustments, straps are riveted to the appliance, using expanding rivets, and the whole is then coated with a finishing compound and is ready for use. Excluding the time taken for curing, production time is approximately a quarter of that required for a similar appliance made of cellulose acetate or moulded leather, which have to be reinforced with steels (Fig. 2, left). The cost is approximately one half.

The advantages of appliances made from "Durestos" are:—

(1) No reinforcement required.
(2) Durable.
(3) Light in weight.
(4) Does not distort with use.
(5) Allows the transference of water vapour, but does not take up free water and, therefore, can be washed.
(6) Unaffected by sweat, urine or fæces.
(7) Low cost of production.
(8) Ease of manipulation.

When cured this material is non-irritant to the skin, but those handling the uncured felt are advised to use a barrier cream on their hands. We ourselves have not been affected by the unpolymerized resin, although cases of phenol-formaldehyde sensitivity occur in industry.

Figs. 3 and 4 show a hip spica produced from the material. A number of such splints have been produced and proved entirely satisfactory. Average strength figures for the cured material are as follows:—Specific gravity .81. Tensile strength 5,220 lb./sq. in. Shear strength 3,623 lb./sq. in. Cross breaking strength 4,000 lb./sq. in. Compressive strength 4,500 lb./sq. in.

The above is a preliminary communication on the use of this material and work is proceeding on its development and varying uses. For help and advice I wish to thank Dr. Woolf Herschell; Mr. G. May, of Dufay-Chromex, Ltd., who kindly supplied free of charge material for the early experimental work; Mr. T. Fisher, my technical assistant, for his manipulative efforts; Mr. T. Whiteley, A.R.P.S., for Figs. 1, 3 and 4; and Turners Brothers Asbestos Co., Ltd., Rochdale, for carrying out strength tests on the material.

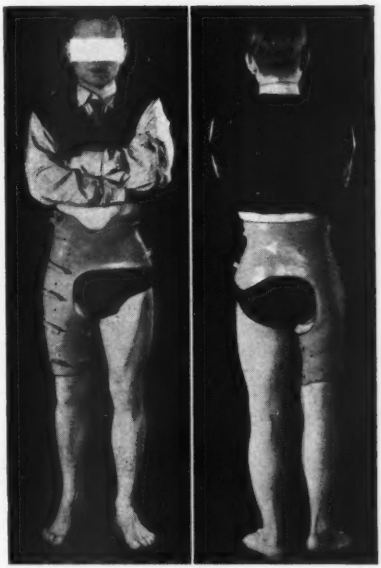


Fig. 4.—Hip spica of "Durestos," shown in use by patient.

RESINS FOR PAPER MAKERS.—The usefulness of "Beetle resins" for treatment of paper to produce high wet strength are outlined in a technical booklet issued by The Beetle Products Co., Ltd., 1, Argyll Street, London, W.1. Data relative to the performance of resin treated papers are tabulated, as well as uses. Whilst the improvement in wet-burst and tensile strength is notable, a much greater improvement is shown in wet-rub resistance, which is an essential property in packaging and other commercial uses. Either urea or melamine resins are used. The resin is not employed as a water-repellent coating, but provides a measure of bonding among the fibres of the paper pulp during manufacture.

Cellulose Acetate Plastics

XIII.—Injection Moulding

By
Vivian Stannett

ALTHOUGH in many ways less spectacular than sheet manufacture and manipulation, the injection moulding technique is overwhelmingly important in the field of cellulose acetate plastics. In recent years in the United States something of the order of 75 per cent. of all the cellulose acetate plastic products have been made by this technique.

It is intended here to give an outline of this technique as applied to cellulose acetate. A great deal of patent and other literature exists on the subject, and the whole field has been extremely well covered by a comprehensive book on injection moulding published last year.[1]

The general principle of injection moulding is most simple. The moulding powder is forced into the plasticizing cylinder by a plunger, where under heat and pressure it liquefies. The fluid plastic is then forced through the nozzle into the cold mould, where it soon sets, and the plunger is returned to its original position, preparatory for a further stroke. In the meantime the mould is opened and the moulded article ejected; the mould is then closed, ready for the next injection. A simplified sketch of the arrangement of the injection moulding machine is given in Fig. 1. It can be seen that the important components consist of the heating cylinder and plunger, the spreader and the feeding hopper. A further important consideration is the mechanism for clamping the closed mould, and for opening and ejecting from the mould.

A large number of British and American machines are available commercially, differing mainly in the design of the features mentioned above. After a discussion of certain general points the individual characteristics of some of these machines will be described. Machines are available in a number of sizes from 1 oz. to the latest H.P.M. giant single-nozzle 40-oz. machine.[2] The cycle time can vary considerably, according to the machine and the moulding concerned.

Feeding

Except for very small capacity machines, it is usual for the feed to be automatically metred into the cylinder to ensure the correct amount of powder being admitted at each stroke. This is often carried out by the use of a simple auxiliary plunger device. The hopper normally is constructed to hold about one hour's supply. The powder is usually dried before use to a very low moisture content, as the presence of excess moisture tends to cause surface imperfections on the finished moulding. Preheating is sometimes carried out to give increased efficiency to the process, but this is by no means a common practice.

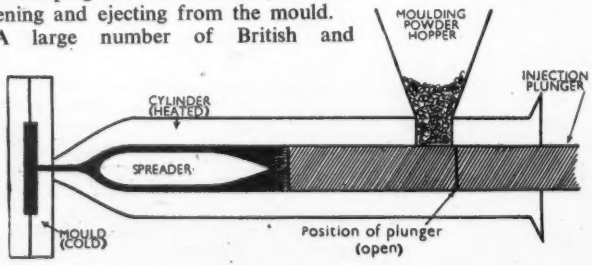


Fig. 1.—Simplified sketch showing principle of injection moulding process.

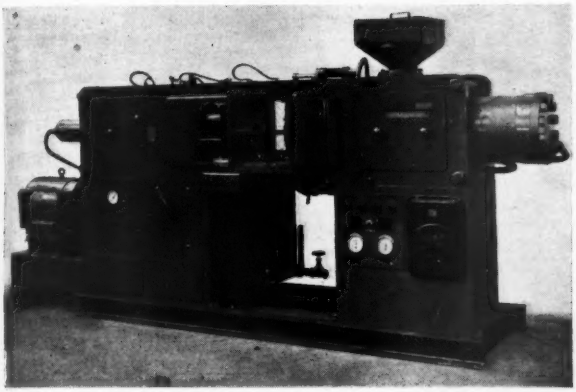
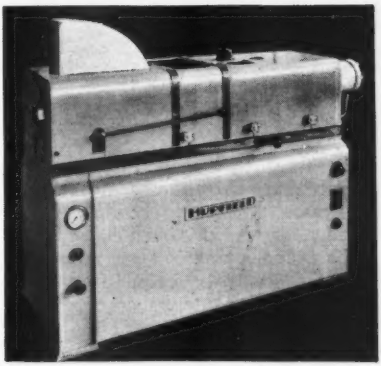


Fig. 2 (left). — This 8 oz. injection moulding machine by The Projectile and Engineering Co., Ltd., was described in "Plastics," Sept., 1947, page 489.

Fig. 3 (below)—Semi-automatic 1 oz. injection moulding machine, by Hupfield Brothers, Ltd., a new British production described in "Plastics," April 1948, page 193.



Heating Cylinder

The productivity of the injection process is largely dependent on the efficiency of the cylinder, and this is dependent on a number of factors. According to D. J. Sloane,[3] the cylinder should be designed with an eye to the following points:—

(1) To plasticize and prepare the rated capacity of the cylinder in the minimum time it takes to set up that amount in a die.

(2) To deliver effective pressure from the plunger to the die, with minimum pressure losses in the cylinder.

(3) To control cylinder temperatures within a few degrees, avoiding hot or cold spots, heat lag and inaccurate readings.

(4) To use a minimum material inventory and maximum efficiency of heat transfer to prevent degrading material through too long a stay in the cylinder, and to reduce material loss at purging. The cylinder should be effective with all thermoplastics.

(5) To streamline the cylinder as to surface finish, contour and hydraulic balance, to permit ease of purging and to prevent the trapping of gases.

(6) To specify tough, dense, abrasion resistant, high heat conducting metals.

(7) To space openings and joints, and to support the cylinder in such a way as to minimize the number of parts and to prevent leakage and contamination.

(8) To avoid small metal sections which are too easily subject to fatigue and breakage, and slots and holes which clog and restrict.

(9) To make the cylinder easy to take apart and clean, without injuring any surfaces.

(10) To employ heaters with mechanical strength and long life, and which are easily accessible for replacement.

(11) To build a design which is equally effective on large as well as small machines.

(12) To build a design which is original and yet reasonably inexpensive.

The heating of the cylinder is usually carried out by simple electrical resistance heaters. Other methods, such as high-

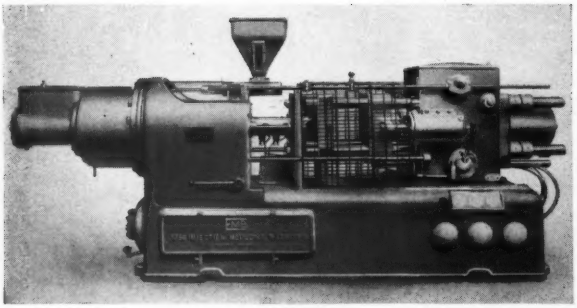


Fig. 4.—Injection moulding machine 9B (4 oz.) by E.M.B. Co., Ltd.

frequency heating, have also been investigated, but so far no commercial application of the newer methods of heating have been made to the injection moulding process. Hot oil heating has, however, been used successfully. Two or three heating zones along the cylinder are employed, plus a separately controlled heating arrangement at or near the nozzle.

The spreader is now fitted in most standard machines, and was introduced to give more uniform heating. This spreader, or torpedo, is an integral part of the cylinder, and is arranged so that the fluid plastic is forced around the spreader through a number of slots or holes. Owing to the speed of heating required, a large heat capacity must be available, and this is achieved by keeping the cylinder at a much higher temperature than would otherwise be needed.

The fluid must be well above its setting point as it has to flow through the runners into the mould, during which time it cools rapidly. Furthermore, the poor heat conductivity and high specific heat of cellulose acetate plastics means that the temperature of the plastic never reaches the temperature of the heating medium itself. Consequently, it is dangerous to leave material too long in the machine, as charring or discoloration will occur.

Most machines are fitted with a system of pyrometers, so that the temperature of the material can be shown. The actual temperatures used vary according to the grade of powder across a range of approximately 350 degrees F. to 500 degrees F.

The mould itself needs to be kept at the correct temperature to avoid too great a chilling, leading to a difficulty in filling the mould, or if the mould is too warm sticking may result. Often the mould is kept cool by circulating cold water through it, but in some cases, as for the injection of heat-resisting grades of powder, the mould is actually heated electrically to the required temperature, usually of the order of 160-200 degrees F.; this may be necessary to prevent premature chilling.

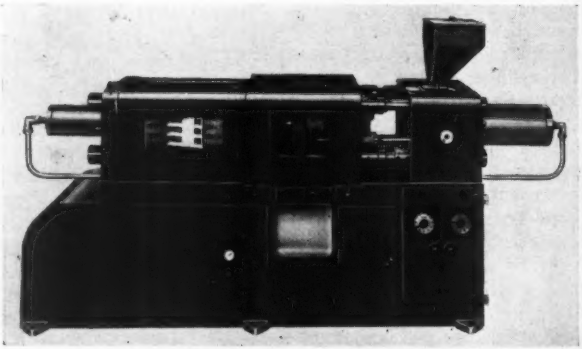


Fig. 5.—Injection moulding machine SH6 (6 oz.) by R. H. Windsor, Ltd.

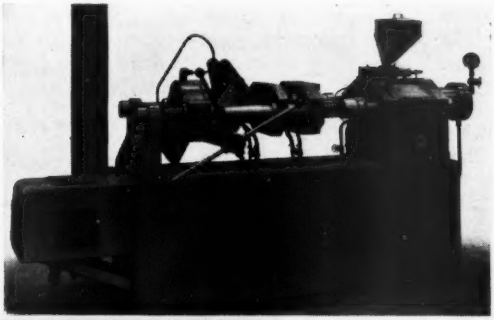


Fig. 6 (left).—"Edgwick" 1½-oz. injection moulding machine, as made by T. H. and J. Daniels, Ltd., for Alfred Herbert, Ltd.

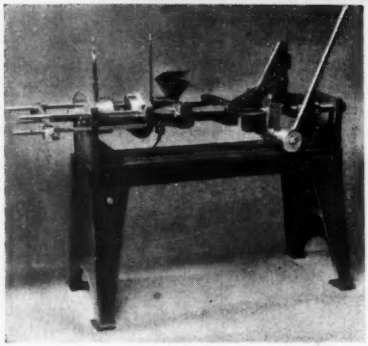


Fig. 7.—The "Westminster" ¾-oz. hand-operated injection moulding machine. (Courtesy, Dowding and Doll, Ltd.)

Fig. 8.—Francis Shaw ¾-oz. hand-operated injection moulding machine. (Courtesy, Francis Shaw and Co., Ltd. and Alfred Herbert, Ltd.)

Pressure

Most commercial machines use hydraulic pressure, both to operate the injection plunger and to open and close the mould by means of a toggle mechanism. A plunger pressure of 8-12 tons per square inch is usually satisfactory. There must, of course, be an overall balance of pressure between that holding the two parts of the mould together and that exerted by the material entering the mould. Any tendency of the mould to open is very undesirable, owing to the flash produced, with consequent disfigurement of the moulding and strain on the mould. All machines have provision for varying the pressure, i.e., pressure, temperature and time cycle can all be varied.

Closing the Mould

The mechanism for closing and clamping the mould can be accomplished by fully hydraulic clamps or by a toggle or link mechanism. The fully hydraulic type of clamp has some advantages, including low maintenance, virtually complete lack of flexing, and the ease of setting the mould. Mechanical clamping mechanism is also operated by hydraulic mechanism and is very fast in action. Maintenance costs are usually heavier for this type of mould closing action.

Modern hydraulic systems are arranged in each case so that as the mould is actually closing the speed is reduced, thus avoiding any damage to the mould halves on closing. The moulded piece is automatically pushed out of the mould cavity on opening by ejector pins.

Injection moulds consist of two halves,

one usually remaining stationary and one movable. The fluid plastic enters the mould from the nozzle through the sprue bushing. The mould is usually fitted with a locating ring to make for easy lining up of the sprue bushing with the nozzle. The size of the nozzle is usually somewhat smaller than the sprue, and several size nozzles can be fitted to most machines.

From the sprue bushing the plastic flows into runners through the gate and so into the mould cavities. There is also a small reservoir section, usually just beyond the runners opposite the sprue bushing, into which the first cold plug of material is injected. The mould is made of hardened or well-plated steel, although many other materials have also been tried out in an effort to reduce the cost of the mould. In addition to straight moulding, injection moulding around inserts and metal formers is also much used. For this purpose it is obvious that a vertically operated press is advantageous.

The design of the mould is, of course, of paramount importance, particularly with regard to the arrangement of the cavities across the parting edge of the mould, of the cooling channels, vents and gate design. Other features to be carefully considered include the mould supports, and the correct placing of the ejector pins. A general point to be watched is the selection of suitable steel with regard to ease of fabrication, cleanliness, resistance to deformation and to wear.

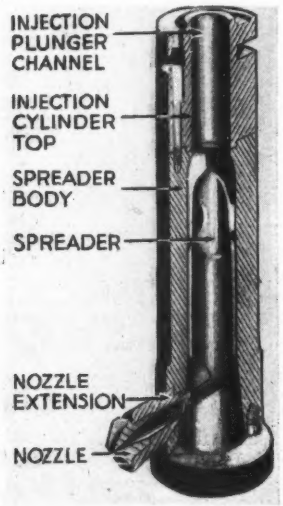


Fig. 9.—Details of cylinder on Lester injection moulding machine (Courtesy, Lester-Phœnix Inc., U.S.A.).

Multicoloured mouldings are made by injecting mixed powders of different colour and flow properties. To produce pearly or wavy effects, powders of different hardness but similar colour are mixed together. The pattern produced by using mixed powders depends on a number of factors including temperature and the size of the various orifices involved. The cellulose acetate moulding powders are usually supplied in granules about $\frac{3}{16}$-$\frac{5}{16}$ in. Powders are available with varying degrees of flow and hardness.

Accompanying illustrations show various British-made injection moulding machines, and also examples from the range available in the U.S.A. Those made by The Projectile and Engineering Co., Ltd., Battersea (Fig. 2) and Hupfield Brothers, Ltd., Stanmore (Fig. 3), have recently received notice in these pages, the requisite reference to "Plastics" being found under the illustration concerned.

The air-operated E.M.B. machine (Fig. 4), by E.M.B. Co., Ltd., West Bromwich, has a compensating feed, controllable heating zone, and timed injection cycle to prevent scamped mouldings. Material from the hopper is measured off into the cylinder at each stroke of the injection ram. The forward movement of the ram simultaneously (1) fills the die cavity with fluid plastic, (2) pushes the previously measured quantity of powder into the beating cylinder, and (3) traverses the feed piston under the hopper for another charge of powder. The travel of the feed piston depends on the weight of the moulding to be made.

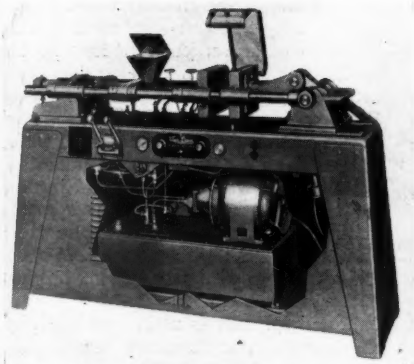


Fig. 10 (above).—Van Dorn 1-oz. injection moulding machine. (Courtesy, Van Dorn Iron Works Co., U.S.A.)

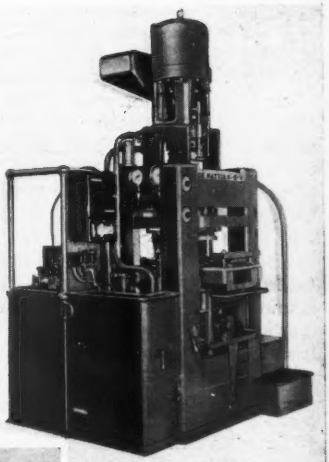


Fig. 13 (above).—De Mattia 12-oz. injection machine. (Courtesy, De Mattia Machine and Tool Co., U.S.A.)

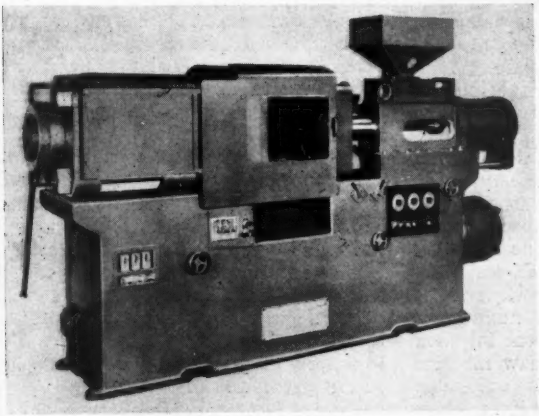


Fig. 11 (above).—Fellows-Leominster 8-oz. injection moulding machine. (Courtesy, Fellows Gear Shaper Co., U.S.A.)

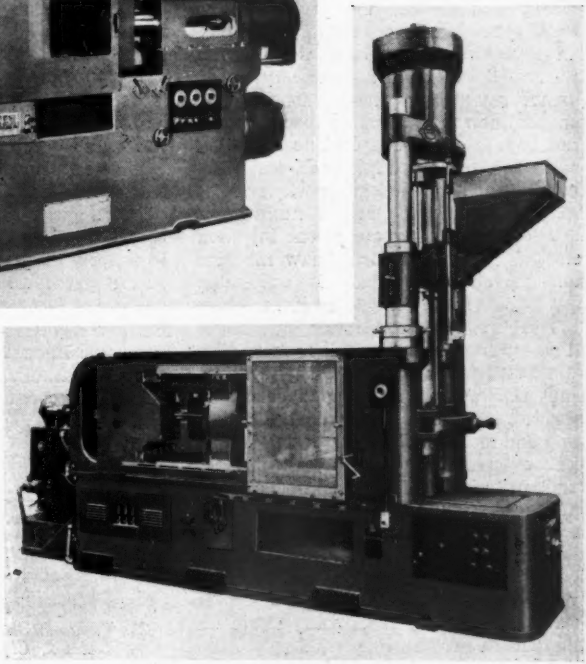


Fig. 12 (right).—Lester 32-oz. injection moulding machine. (Courtesy, Lester-Phœnix Inc., U.S.A.)

All operational movements are controlled by a single lever, and the mechanism is designed so that the various functions can take place only in correct sequence.

The improved 6-oz. machine by R. H. Windsor, Ltd., London (Fig. 5), was shown at the recent Toronto International Trade Fair.

The "Edgwick" machine (Fig. 6) is manufactured by T. H. and J. Daniels, Ltd., Stroud, exclusively for Alfred Herbert, Ltd., Coventry. An important feature of this machine is that, in addition to the air operation of the injection plunger, air is also used for the final die-locking clamp giving 20 tons pressure. The single lever air control first operates the air clamp, then the injection plunger.

The "Westminster" hand-operated machine (Fig. 7) by Dowding and Doll, Ltd., London, is similar in design to that by Francis Shaw and Co., Ltd., Manchester (Fig. 8). Both machines are ideally suitable for the production of small mouldings where the installation of an expensive automatic machine is not warranted; their installation by many manufacturers of plastic articles has enabled new markets to be reached without high capital outlay. The moulding cycle can be very rapid, and for small component parts multiple cavity moulds may be employed, i.e., a number of articles can be produced at one injection stroke. In the Francis Shaw machine the movable die plate is adjustable for moulds from 2 ins. to 10 ins. thick.

The Fellows-Leominster machines[4] (Fig. 11) are horizontal and are fitted with a specially designed tapering cylinder and separator. This arrangement is said to lead to a better heat distribution and more efficient plasticizing action. The cylinder, together with the hopper and material feed mechanism, can be advanced and withdrawn hydraulically as a unit, making for easier cleaning and setting up, etc. The machines are fitted with volumetric feed control and a straight line toggle design which is claimed to greatly reduce any strain on the pins due to shearing.

The Lester 32-oz. machine[5] (Fig. 12) has several unique features, the most striking of which is the vertical cylinder with the nozzle set at an angle bringing the mould mechanism, etc., on to the horizontal. Some details of the cylinder are shown in Fig. 9. Another interesting item about this machine is that the spreader itself is heated by means of a separate heating unit. The fluid plastic passes the spreader in an annular ring path, both the spreader and the cylinder being heated. This is claimed to give a much more efficient heating action than when the normal unheated spreader is used. In addition, the machine has three separate heating zones along the cylinder. The whole is fully automatic and hydraulically operated, a special four-column toggle linkage supporting the mould against the injection pressure. The machine is rated as capable of plasticizing 120 lb. of material per hour. Feeding is by means of a new cylindrical compensating feeder device, which gives an exactly repeating amount at each shot, easy feeding being a feature of the vertical cylinder design.

The Van Dorn 1-oz. machine[6] (Fig. 10) is a small horizontal machine with the injection plunger and the mould closing mechanism operated by hydraulic cylinders. The pressure is developed by a 2 h.p. electric motor through a gear pump. The cylinder is provided with a spreader and has two heating zones. It is capable of plasticizing about 4 lb. of acetate per hour.

The De Mattia machines[7] are made as horizontal or vertical models; Fig. 13 shows the 12-oz. vertical model. Both are fully hydraulic machines with a plasticizing capacity of 140 lb. per hour.

(To be continued.)

REFERENCES

(1) *Islyn Thomas, "Injection Moulding of Plastics." (Reinhold, 1947).* **(2)** *"Modern Plastics," 1948/25/May/113.* **(3)** *Lester Engineering Co., Cleveland, Ohio.* **(4)** *Fellows Gear Shaper Co., Vermont.* **(5)** *Lester-Phœnix Inc., Cleveland, Ohio.* **(6)** *Van Dorn Iron Works Co., Cleveland, Ohio.* **(7)** *De Mattia Machine and Tool Co., Clifton, N.J.*

LETTERS TO THE EDITOR

Correspondents are reminded that a stamped and addressed envelope should be enclosed in all cases where a personal answer is desired. It is understood that any letter received may be published at the discretion of the Editor.

Origin of Printing on Plastics

Sir,—The correspondence on printing on plastics, which has appeared in recent issues of "Plastics," has been very interesting to me, as the firm with which the writer is connected was probably the first to use laminated sheet containing a printed design.

In the early part of 1933, it was reported that a sheet of laminated, on inspection, appeared to contain an unusual blemish. Upon further examination, it was seen that a large spider had committed suicide between the press platen and the outer cloth layer, and had become embedded just below the surface.

A few weeks later, the writer, casually toying with the piece containing the spider, conceived the idea that if it was possible to impress a spider, it should also be possible to print a design. Experiments were carried out in collaboration with Bakelite, Ltd., and so for the past 15 years we have been using laminated sheets, the fabric of which is printed all over with a design.

Enclosed is a photograph, the upper part of which shows this spider, the lower part some of our present-day material.

Hayes, Kent. H. ERIC SCOTT.

Plastic "Tiles" for Walls

Sir,—We have read with interest your editorial on the "Tale of a Tile," and should like to draw your attention to the fact that we are manufacturing a plastic material known as "Fibrenyle." One of its uses is the spreading in the dough form directly on pre-cast concrete blocks.

Fibrenyle sets hard and adheres perfectly, even to the extent that when forcibly removed it will tear the surface of the cement. It is possible to build walls that have been treated with Fibrenyle in the normal manner, and to cover the joints with beading or fill in with further material of the same colour. Fibrenyle is available in a great variety of colours, is waterproof, and can be cleaned with soap and water.

FIBRENYLE, LTD.
84a, Kilburn High Road,
London, N.W.6.

Rising Italian Plastics Production

The Italian plastics industry is among the very few production fields of the country with considerable export outlets. Due to the relevant demand for plastics in almost all countries, Italy does not feel the American competition.

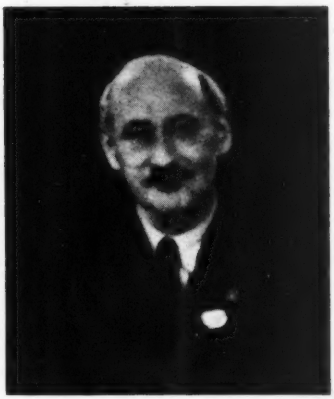
Production of synthetic resin materials is rising. By now, compared with 1946, the production of phenolics and cresol resins has increased 75 per cent.; that of polystyrene resins by 27 per cent.; Galalite, 100 per cent.; cellulose, 110 per cent.; glycerine resins, 83 per cent. Imports of raw materials, especially American cotton linters, being ensured, the Italian cellulose production is steadily reviving.

For the production of Galalite, the raw material (casein) has not always been available. It is hoped that casein imports will shortly be sufficient for the five plants, which have an annual output of 1,300 tons.

New ways of using nylon have been developed; the nylon is being produced at one Italian plant with American licences. The production of synthetic bristles and yarns for fishing-nets, based on nylon, has been attended with success.

The Late Julius Veit,

A.M.I.E.E., F.P.I.



IT was with deepest regret that we learned of the death of Julius Veit, general manager and founder of Duratube and Wire, Ltd. The news came to us just as we were going to press with our June issue, with which we included a brief announcement.

Julius Veit obtained his technical education on the Continent and commenced his plastic activities with the moulding of thermosetting materials in 1921. We met him first in 1937 when, with a wealth of European experience, he was producing not only p.v.c.-coated wire for electrical applications, but a bewildering variety of coloured strips and tubes which he prophesied would one day be used for shoes, bags, toys, and a host of fancy goods, as also for industrial applications.

In the critical years of 1939-40 he brought into play the remarkable foresight for which he was so well known amongst his many friends, and commenced the manufacture of p.v.c.-insulated wires and cables and electrical insulating sleevings. His development and researches were so good that approval was granted to his products by all Government chiefs of the fighting services. His knowledge and experience he imparted to others by lecture and publications, and many early pioneers were facilitated in their work for the national effort. On account of his technical achievements, he was always consulted by the Admiralty and other Government departments. Because of rapid growth in the utilization of p.v.c., the loss of rubber plantations during the war was minimized. Here Julius Veit played no small part.

Of the man himself, Veit was symbolized by the two "cocker spaniels" which he adopted as his registered trade mark, and the accompanying caption, "Trustworthy friends." With this outlook he ran and developed his factory, in which he was looked upon more as a father than as employer. Well loved by all his employees, he had the happy knack of imparting to his people that the company and its successes were theirs.

Raw Materials Difficulties in Austria

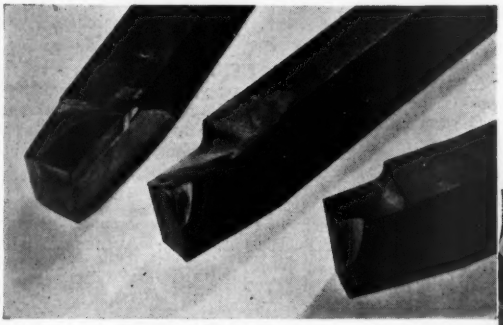
The Austrian plastics production was restarted at the end of the war. At present, only technical plastics are being produced.

Before 1937, Austria produced only plastics for the luxury industries. Due to the strong German competition favoured by export bonuses, production of technical plastics was impossible. During the war, the Vereinigte Chemische Fabriken commenced an output of technical plastics. At present, however, production is limited because of raw materials difficulties. Two important raw materials must be imported: phenol and formaldehyde, the former from the U.S.A., the latter from Sweden, Belgium and Switzerland.

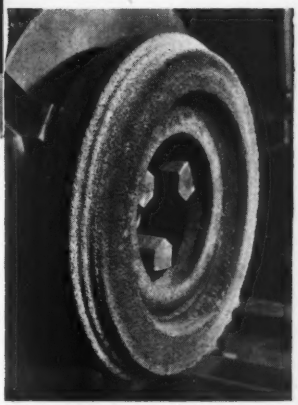
Domestic production of these raw materials would lead to an increase of the plastics production by five to eight times the present figure. A vast programme has been set up to reach this goal. At the end of this year or at the beginning of next, phenol and formaldehyde will be produced in Austria; synthetic phenol by the Linzer Stickstoffwerke, phenol through tar-distilling by the Theerag Co., and formaldehyde by the Vereinigte Chemische Fabriken. The required methanol will also be produced at the Linzer Stickstoffwerke.

PRODUCTION NEWS

Raw Materials, New Plant, Works Organization, Control Apparatus, Research, Personal and Trade Notes



(Left) Comparative resistance to abrasion of "Wimet" tungsten carbide and high-speed steel tools; the "Wimet" tool, on the extreme left, was used for cutting the vitrified grinding wheel (below).



TUNGSTEN CARBIDE TOOLING.—Physical demonstrations of tungsten carbide tooling were the outstanding feature of this year's display by A. C. Wickman, Ltd., at the Castle Bromwich Section of the B.I.F.

Early difficulties associated with carbide tooling have tended to persuade production engineers that the field of application of this material is limited to certain well-defined purposes. Developments by Wickman engineers over the past decade, however, have proved the inaccuracy of this conception. Few materials can now offer serious resistance to carbide cutting tools; in addition, a gratifying result of their use is a notable increase in production per man-hour, which leads to immediate substantial savings in costs.

Proof of the inherent wear resistance and cutting qualities of "Wimet" tungsten carbide was seen in a vitrified abrasive wheel, cut and formed by a standard cutting tool. The tool itself was also available for inspection, together with two high-speed steel tools which attempted the same test, but with disastrous effect. The finished wheel and the tools referred to are the subject of two of our illustrations.

INJECTION MOULDING MACHINES.—The Projectile and Engineering Co., Ltd., Acre Street, Battersea, London, S.W.8, announce that they have now carried out extensive tests with their 4-oz. and 8-oz. injection moulding machines, many of them on continuous day and night production runs with a number of moulders in this country. The results have shown that in all important aspects the standard 4-oz. machine is up to the specification of an automatic cycle 6-oz. machine, whilst their standard 8-oz. machine is comparable with a 12-oz. machine. To ensure the maximum capacity on continuous production runs, a number of improvements have been introduced. These include larger cylinders, increased capacity pumps to give a still higher rate of injection, greater area of platens, longer stroke, and still heavier side frames.

In order to cover a wider field in the plastics industry, this company has decided to introduce a small all-hydraulic, non-automatic machine of 2-oz. capacity which will be due on the market in the autumn.

CASEIN PLASTICS.—We have received from Erinoid, Ltd., a most attractive brochure which they are sending to their friends in all parts of the world to tell the interesting story of casein as a plastics material. The production of this brochure,

as an example of colour printing, is really an achievement, for it reproduces to perfection the delicacy of colour and variety of effect which are so characteristic of Erinoid. This is noticed particularly in the illustrations of buttons and buckles, which the company claim to be two of the most popular products yet made from Erinoid. Brooches and earrings, handles for furniture and umbrellas, fountain pens, chessmen and poker counters, are shown as other instances of usages, emphasis being laid on the beautiful polish that is possible. The text, prefaced by an historical note, deals in turn with the manufacture of casein and of casein plastics, manipulation, and sizes of tubes, rods and sheets in the standard Erinoid range. Some particularly useful notes are included under the heading of manipulation. Copies of the brochure may be obtained on application to Erinoid, Ltd., Lightpill Mills, Stroud, Gloucestershire.

BRITISH MOULDED PLASTICS, LTD. By an unfortunate error we referred to one of the mouldings in our illustration of part of the exhibit by British Moulded Plastics at the 1948 B.I.F. (June issue, page 290) as that of an aircraft instrument panel. Actually it is the instrument panel for a V.8 Pilot motorcar (Ford Motor Co., Ltd.).

MICANITE AND INSULATORS CO., LTD.—The Foremen's Association of this company held its 6th annual dinner at "Frascati's" on May 8. The president, Major S. M. Mohr, M.C., and about 100 members and guests were present, including guests from the Foremen's Associations of Metropolitan-Vickers Electrical, British Thomson-Houston, and Edison Swan.

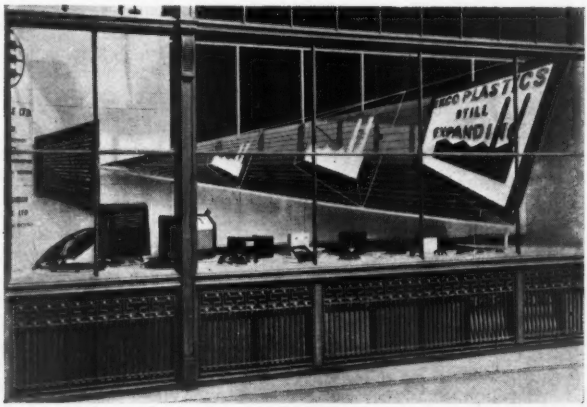
CATALIN, LTD.—The directors recommend payment of a final dividend of 10 per cent., less tax, on the ordinary shares for 1947, making with the interim dividend of 10 per cent. a total distribution of 20 per cent. They announce that the profit for the year, before taxation, is £71,597 as compared with £66,021. Taxation absorbs £41,000 (£44,651).

ERINOID, LTD.—The directors recently proposed increasing the issued capital by 330,000 4½ per cent. redeemable cumulative preference £1 shares and 330,000 ordinary 5s. shares, which it is proposed to issue by way of rights to stockholders.

NATIONAL PLASTICS, LTD., announce that their two operating companies, British Moulded Plastics, Ltd., Avenue Works, Walthamstow Avenue, London, E.4, and Moulded Products, Ltd., Chester Road, Tyburn, Birmingham, 24, have concluded an agency agreement with The Laycock Engineering Co., Ltd., Victoria Works, Millhouses, Sheffield, 8, appointing them sole selling agents to the Railway Authorities in Great Britain and Northern Ireland, as and from July 1, 1948.

"WORKERS' PLAYTIME" was broadcast from the rubber and plastics works of Wallington Weston and Co., Ltd., at Frome, Somerset, on June 4.

BIRTHDAY HONOURS.—The King's Birthday Honours List included the names of Mr. H. W. Cremer, president of the Institution of Chemical Engineers (C.B.E.), and Professor Alexander Findlay (C.B.E.) for services to chemistry.



Ekco Plastics provide the current display in the window of the London office of E. K. Cole, Ltd. The company's development as general moulders to the industry is stressed.

PLASTICS INSTITUTE NOTES

Annual General Meeting.—The Plastics Institute held their annual general meeting at the Waldorf Hotel, London, on June 23, when Mr. W. H. Graesser-Thomas was elected president, and Mr. J. L. Daniels was elected chairman of Council, for 1948-49. Messrs. C. R. Todd, R. B. Cartwright, T. Gordon and H. Jones were elected as new members of the Council.

New Members.—Recent elections to Fellowship of the Institute include Messrs. G. J. Taylor, E. G. Couzens, W. Bowen, D. N. Davies, F. E. Birkby, H. V. Potter, W. Charles Waghorne, V. E. Yarsley and J. Prior. Elections to Associateship include A. R. Oswin and H. R. Poole. Membership of the Institute now exceeds 1,800.

Founder Fellowships.—At the annual general meeting, certificates of Founder Fellowship in appreciation of long and outstanding service to the Institute were presented to Messrs. C. C. Last, M. P. MacFarlane, A. W. Sherwood, E. J. Wilkins, F. G. Rudd, C. Chapman, J. Taylor and C. S. Dingley.

Education.—A meeting for the advancement of education in the plastics industry in the Leeds area was held in Manchester on June 13, under the chairmanship of Professor H. Wright-Baker. Among those present were Mr. J. R. Petrie, principal of St. Helen's Technical College; Mr. A. M. Parkinson, principal of Newton Heath Technical School; Mr. R. P. Cartwright, of Metropolitan-Vickers Electrical Co., Ltd.; and Mr. Ferguson, of Ashdowns, Ltd.

Courses in plastics technology leading up to the Diploma examination of the Institute, and later towards Associateship examinations, will be given in the coming year at St. Helen's Technical College and at the Municipal College of Technology in Manchester.

NOTES FROM THE BRITISH PLASTICS FEDERATION

United States Visitor

Mr. George Clark, president of the Society of the Plastics Industry, Inc., is visiting this country and will be entertained at luncheon by the Council of the Federation on July 26.

Prices and Profits

The Council of the Federation have recommended to all members that they make every endeavour to comply with the recommendations contained in the Report on Prices and Profits prepared by the Federation of British Industries. Reports have already been received from members giving details of the action they have been able to take to implement these recommendations.

Government Controls

The Federation is obtaining information from members on the various Government Controls affecting the plastics industry, with a view to making representations for modifications to the appropriate Government Departments.

Statistics

Steps are being taken by the Moulders, Fabricators, and Laminated and Fibrous Products Groups, to obtain various statistics relating to the plastics industry.

Wear and Tear Tax Allowances

As a result of representations by the Federation, the Commissioners of Inland Revenue have agreed that the wear and tear allowances for machinery and plant used in the plastics industry, for 1948-49, shall be as follows:—

	Per cent.
Up to and including double shift	10½
Exceeding double shift but not exceeding 120 hours per week ...	13
Exceeding 120 hours per week ...	15

This is exclusive of the additional allowances already granted under the relative Finance Acts.

Visit to F.P.R. Laboratory

Continuing the close association which exists between the Synthetic Resin Section of the Federation and the Forest Products Research Laboratory, the Technical Committee of the Synthetic Resin Section paid a visit to the laboratory on May 27.

Moulding Powder Imports

Imports of moulding powders during April were as follows:—Phenolic, 782 tons; polystyrene, 126 tons; urea, 47 tons; cellulose acetate butyrate, 3 tons.

Federation Publications

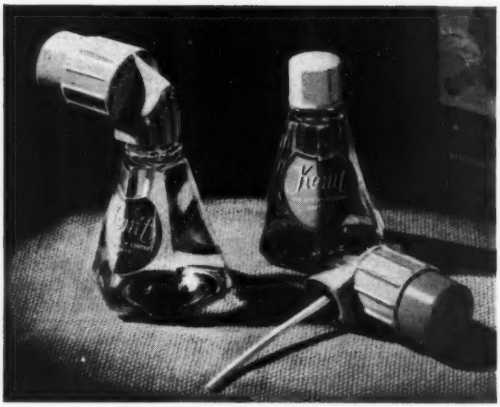
A booklet outlining the work and objects of the Federation has now been published.

Copies of the Buyers' Guide prepared by the Moulders, Fabricators, and Laminated and Fibrous Products Groups have now been circulated at home and overseas.

Specification for Sinks

Arising from discussions at the Sanitary Industry Appliance Committee of the British Standards Institution, meetings of manufacturers of acrylic sinks are being held by the Federation and a draft specification for such sinks is being prepared for submission to the British Standards Institution.

New Productions from the Moulding Shops



Spray Attachment

The cap and screw-on spray pump attachment for this hair lustre restorer pack are both moulded in green "Beetle," for Drugs, Ltd., by the Streetly Manufacturing Co., Ltd. The spray pump attachment comprises two distinct components—the nozzle assembly itself and the plunger.

Thermos Flask

While on the B.I.F. stand of British Artid Plastics, Ltd., Mr. Bamberger handed us a vacuum flask his company is manufacturing, with the words: "This is the solution to your inquiry about vacuum cleaner brushes." The flask, a photograph of which we include herewith, is most sensibly protected with a soft rubber fitting round the top of the body, and the top of the neck, thus protecting the plastic moulding from breakage when dropped. This is a most excellent idea and such protection is obviously indicated in the case of vacuum cleaners. We should like to point out, however, that our editorial on "Brush Backs" on p. 111 of our March issue referred not to protection of brushes but to the prevention of cruelty to furniture by the said brushes. The flask is made for John F. Thomas, Ltd., 20 Story Street, London, N.1.

Engraved Tray

This engraved "Perspex" tray was exhibited at the Hotel, Restaurant and Catering Exhibition, held in London early this year. It was made by Pasco Industries, of Slinfold, Sussex. The tray is engraved from the underside.

Electroplating on Plastics

In answer to the publication last month of the letter from A.B., asking for information, we have received from B. Berger and Co., Ltd., of 176, Albion Road, London, N.16, some samples of their productions. The silver-plated egg-cup, shown in the centre of our illustration, is an electroplate on a phenolic moulding. The other samples are plated thermoplastics.

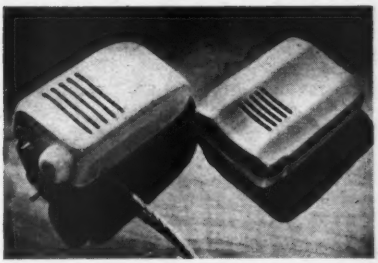
Bottles for the Laboratory

These bottles, available in 4-oz., 8-oz. and 16-oz. sizes, are made of "Telcothene" (a mixture of polythene and polyisobutylene) by the Telegraph Construction and Maintenance Co., Ltd., at Telcon Works, Greenwich, S.E.10. In their manufacture,

co-ordination of design and utility has been achieved. Mechanically robust (no cracking or splitting occurs when the container is dropped), inert to most chemicals and fitted with a liquid-tight screw cap, they are indispensable in the laboratory. At ordinary temperatures, Telcothene will withstand the action of any aqueous solution, including strong caustic soda, concentrated hydrofluoric, nitric and sulphuric acids, indefinitely; hydrofluoric acid causes slight discoloration after some time, but no deterioration takes place. At temperatures approximating to the boiling-point of water, the bottles will withstand the action of concentrated hydrochloric and hydrofluoric acids, and of diluted nitric and sulphuric acids. There is no deleterious effect by 50 per cent. soda solution at this temperature. These bottles, moreover, are unaffected by attack from the higher esters, such as dioctylphthalate, but it is not advisable to use them with such organic liquids above 50 degrees C. Neither are they suitable for volatile solvents, e.g., alcohols, acetone, petrol or hexane.

Deaf Aid

These "deaf aid" cases have been fabricated from "Celastoid" sheeting, a product of British Celanese, Ltd. The material in question was chosen on account of its high-gloss finish, variety in colour that was possible, and its non-resonant properties. The prototype was made in the British Celanese Plastics Development Section for Allen and Hanbury, Ltd. "Celastoid" sheet was displayed at the 1948 B.I.F. in a range of pastel shades, opaques, translucent, clear and shell-mottle finish. The end-uses of sheet and moulding powder included compacts, clock bezels, lampshades, spectacle-frames, combs and musical instruments.



Presentation to Sir James Swinburne, F.R.S.

SIR JAMES SWINBURNE, Bart., F.R.S., has recently completed 44 years active chairmanship of Bakelite, Ltd., and its predecessors. To mark this occasion he was presented with the tray illustrated above. The tray is made of "Warerite," and the coat-of-arms used by Sir James is reproduced in the base as an integral part of the laminate. Our second illustration shows Sir James and Lady Swinburne receiving guests at the reception which preceded a dinner given in their honour at the Dorchester Hotel by the directors of Bakelite, Ltd.

Sir James has had a remarkably active career. In the early years of this present century, he was among the foremost world authorities on electrical engineering, and at the time of his election as president of the Institution of Electrical Engineers in 1902 he was the youngest holder of that office hitherto known by the I.E.E. His work in the electrical field included the pioneering of electric lamps in conjunction with Swann, for whom he started a factory in Paris and later in the United States. In 1906 he was elected as a Fellow of the Royal Society.

A few years before this date he became interested in plastics and in 1904 started a company called the Fireproof Celluloid Syndicate, Ltd., the object of which was to develop synthetic resins. Bakelite, Ltd., is the direct successor to the Fireproof Celluloid Syndicate, and Sir James has maintained an active interest in the affairs of the company from its inception.

This year Sir James celebrates his golden wedding and his 90th birthday.

Quality Control in Plastic Moulding—VIII

By W. M. HALLIDAY

In this section the subject of quality control by means of fraction defective methods and charting is fully discussed.

Explanations are afforded of the ways in which such fraction defective control charts may be constructed and applied. Several interesting illustrations are also given which demonstrate the successful way in which this method of control may be employed for the more reliable inspection and the maintenance of specified degrees of quality, with both compression- and injection-type moulded articles.

WITH very large numbers of moulded plastic components, the maintenance of strict dimensional accuracy is usually unimportant, in comparison with other requirements to be attained. Thus it often happens that the surface finish, weight, or general appearance of a moulding are the chief points to be held within a given standard of quality. Examples of such mouldings are those intended for purely decorative, ornamental, or domestic uses; for instance, innumerable kinds of toys, smokers' requisites, dishes, bowls, lamp-shades, buttons, trays, and like articles.

All such mouldings possess one common feature when viewed from the moulding shop inspector's angle. The important non-dimensional features which have to be maintained to a given standard of quality are almost invariably incapable of being measured or checked by any of the precision measuring instruments commonly available to the inspector, some of which were briefly described in the preceding articles.

In addition to the above considerable proportion of mouldings there are other forms possessing a single dimension which has to be held within relatively close limits of variation—which, however, is not as fine as those imposed in the case of a precision type moulding required for electrical and certain industrial purposes.

Often with such moulded articles it may prove difficult, undesirable, or even impracticable to measure or gauge such a dimension by means of any of the customary types of precision equipment. Some plastic moulding factories, indeed, may find they do not possess a sufficiently skilled inspection staff for the accurate measuring and gauging of moulded components to hold them within precision limits of error. This very often arises in the case of moulders producing mainly non-precision types of moulding, which hitherto have received but the most cursory inspection or examination, the chief reliance for accuracy, or ability to meet other requirements being left to the mould operator and setter.

With other works it may be found that the time likely to be entailed in undertaking such gauging and measuring of non-precision components is prohibitive.

The rate of production of lightweight small size mouldings, with multi-impression tools, may prove so large as to constitute a serious obstacle in the way of checking by normal gauging or measuring operations, when using precision instruments of the kind already mentioned in the previous sections in this series.

For all such plastics mouldings with the above-mentioned features, where it is genuinely undesirable or impracticable or unnecessary to employ direct reading measuring inspection practices, another method of gauging and controlling the quality of the articles as they are being produced from the moulds must be adopted.

Such a method is in fairly widespread use throughout general engineering processes, and consists of an adaptation of the usual quality control procedure

already described in the preceding sections of this series. This adapted form of control is known as "fraction defective quality control," and it is the purpose of this present article to explain the underlying principles, the kind of control charts required, and their application to plastic moulding productions.

With fraction defective forms of control, measuring of the dimensions of a component is generally not undertaken at all. Instead, batches of workpieces are taken, or representative sample sets from such large batches, and these are weighed, gauged or checked against master-approved sample components. The relative number of visibly defective parts in each batch, or group representing a batch, is then carefully counted, and the results logged on to a suitable chart or graph provided for the purpose of effecting control.

With this method, where a component dimension has to be checked for controlling its variations, simple gauges generally of the "go," "not go" type are employed. Their use, be it understood, determines only whether that portion of the component is within the specified limits set for the job. It is important to point out that such gauges ascertain only this point, and are incapable of informing the inspector by how much the actual component dimension is above or below the required nominal size, which information is vitally important for successful compilation of quality control charts hitherto considered in earlier sections.

The actual checking of parts under fraction defective practice will chiefly comprise gauging of the kind just mentioned, or even only a purely visual examination of the parts in order to detect visible flaws or blemishes in the surface finish. Alternatively, the parts may be compared with a known acceptable sample component in order to observe the degree of agreement in shape, contours, colours, or general configuration. On the other hand, the components may be weighed, or checked simply by an estimation of their quality and acceptability based upon the practical experience and training of the inspector making the check.

The choice of such methods will, of course, be largely dependent upon the nature of the moulded article and the requirements which have to be satisfied.

Whichever method is finally selected for checking the part, it will be understood that some thought and care must be bestowed upon the provision of suitable gauging, or checking equipment. Because such gauging or checking tools will necessarily be of a very simple kind, in compression with those employed for measuring precision type mouldings, there may be a tendency to afford their design, construction, and application an insufficient amount of attention.

Such an attitude would, of course, result in the provision of equipment which may prove unsuitable by allowing too great a latitude to the purely "human element." In so far as this should arise the results obtainable from control would most likely be satisfactory.

Even though the gauging, checking, or inspection methods and tools are of the most rudimentary kind, they can be correctly designed and made, and so be capable of affording results without an undue reliance of the personal factor. The more the latter is allowed to obtrude into inspection and gauging operations, the greater likelihood or risk there is of errors, mistakes and oversights occurring.

Principles and Construction of Fraction Defective Control Charts

In the system of fraction defective control, measurements of a component are not taken; instead, gauging and checking of the kind just described above are employed. A batch of parts thus gauged would reveal a certain quantity of defects, or rejects, as below or above the checking limits. This quantity, when expressed in the form of a proportion to the whole batch, is the "fraction defective" of that batch. In quality control terminology this fraction defective value is denoted by the symbol "p."

The datums delineating the required control limits on the fraction defective

chart are based upon and derived from the average "fraction defective" of a number of such batches, of components of equal quantity, produced as near as possible under the same operating conditions. This average value is known by the symbol "$\bar{p}$."

A number of slightly different methods may be employed for taking samples from a continuous bulk production, but generally each one will be found to be only a slight variant of the undermentioned method.

Sample batches of mouldings are taken from the mould and a percentage of individual components comprising each batch will then be gauged, or given a visual examination to determine the agreement or otherwise with the predetermined standard of quality required to be maintained.

A sufficiently representative number of such sample batches should be taken in order to obtain really reliable results. Preferably the number of sample batches selected as the basis for quality control by "fraction defective," should be considerably larger than those chosen for quality control by measurement.

The sample batches when being selected from the moulding press, or injection machine, as the case may be, should be taken quite at random, thereby securing a sound average sample of the bulk quantity. The number of individual components comprising each sample batch, as well as the number of batches will be determined to a large extent by the rate of output obtained from the mould.

Broadly speaking, the size of the sample batch and the frequency with which such batches are taken from a production run, should be so regulated to provide that not less than 25 per cent. of the total components produced are samples. With some types of mouldings, particularly multi-impression injection tools, the rate of production will be exceedingly high. This feature would necessitate increasing the above-mentioned proportion; it may be advisable to lift it to as much as 50 per cent. of the total number of articles moulded.

Alternatively, to meet such circumstances satisfactorily it might prove more convenient to take sample batches from the bulk production at more frequent intervals.

In addition to the above factors, a third very often demands some consideration, the satisfactory solution of which may entail a departure from the above proportions. It is essential, if reliable results are to be derived, that a sample batch taken from production shall be sufficiently large to produce at least three defective components. The reasons for this will become clearer later in the discussion.

With samples for fraction-defective charting control the quantity or percentage of individual mouldings sampled at each check should always be considerably greater than is the case with sampling for quality control by direct measurement.

The essential statistical principles and methods to be employed for the collection of the necessary production data, and the ultimate construction and application of fraction defective control charts, will doubtless be most clearly understood by working through all the stages in the process of establishing control for a typical plastic moulding. This will be performed in exactly the same manner as will be required in the moulding shop or inspection department, whilst the plastic-moulded article will be of a kind closely similar to a large variety of components regularly being produced.

For this purpose a 10-impression mould of the injection type has been chosen for consideration. The mouldings produced from this tool consist of small cylindrical hollow caps having one end closed. The mouldings are very small in size, and weigh but a fraction of an ounce each. The chief features required to be quality controlled are the diameter of the blind hole, and the quality of the surface finish on the exterior of the part.

The hole diameter has to be maintained within fairly generous tolerances, viz., plus or minus .005 in. This permissible range of variation permits the use of

ordinary "go" and "not-go" solid plug gauges of the kind very commonly employed in the moulding shops. The "go" end of such a gauge for our example moulding would be made to the nominal diameter less .005 in., whilst the "not-go" end would be made nominal diameter plus .005 in.

For checking the quality and general suitability of the external surface finish of the moulded parts, reference is made to a standard sample moulding which possesses the known and agreed degree of smoothness and finish required in the bulk production.

The output from the mould for a normal day's production is quite large, averaging 600 mouldings per hour. One shot per minute was found by careful tests to be quite easily possible and capable of being consistently maintained over appreciably long periods. This latter incidentally is a most important point which has to be determined as a preliminary step to the setting-up of quality control by fraction defective for the reason following.

With most plastics mouldings of the non-precision type, where accurate dimensions are relatively unimportant, production from the mould is usually characterized by considerable variation in volume day by day. Such variations will be due to the vagaries of the human element in respect of the operation of the machine, or the care taken with the mould. Particularly are such variations in output likely to occur with semi-automatic type injection machines, or in connection with moulds involving the manual actuation of cores, the application of inserts, or the hand injection of the finished mouldings.

The net result of such variations in the scale of output throughout a daily production run, when quality control inspection methods are in use, will be that the inspector will find at certain times of the day considerably increased quantities of parts await the test.

Now, as will be explained more fully later in this article, with fraction defective methods of control, only a certain proportion of the mouldings produced during each stipulated period will be checked and the results plotted on a control graph or chart. It will be appreciated if at some periods the total number of parts produced is considerably increased, for any reason, then the proportion selected for gauging and checking, if held at the pre-determined level, will be reduced below the proper ratio and may result in unreliable data and misleading charting of the production progress.

It will therefore be realized how important it is to ensure that production from any particular mould must first be stabilized to avoid excessive variations in the output. To accomplish this object it may be necessary to modify or overhaul the mould, to readjust or recondition the injection machine and its auxiliary equipment, and very often to institute some degree of training for the machine operator to ensure that he is fully conversant with the requirements of the mould and its correct operation.

All this activity must be conducted to a satisfactory end before commencing to extract the production data needed for the construction of the quality control charts.

Ascertaining Production Data

As with quality control by measurement, the preliminary requirement needed for the successful and reliable establishment of fraction defective control is the obtaining of production data based on the normal operation of the mould and machine. Such data will mainly comprise the following matters:

(a) The total quantity of parts produced per given period of time.

(b) The number and proportion of faulty or defective parts per selected batch.

(c) The nature and extent of such defects, together with investigation of the causes.

(d) The degree of correctness or agreement with pre-determined standards of size of finish.

Information of the above nature is essential, because from the guidance it affords the necessary control graphs will have to be computed, constructed and operated throughout the production run.

Already it has been explained that the quantity of parts selected from each batch for gauging should not be less than 25 per cent. of the total production; this proportion is important, but may have to be very considerably increased.

With the moulding now under consideration, where the rate of output is very high, i.e., 600 mouldings per hour, to obtain really reliable results and a truly representative check over the large-scale bulk production, the quantity of mouldings comprising each sample batch for checking should be in the neighbourhood of 40 per cent. of the total production.

Therefore, with an hourly output of 600 components from the 10-impression tool, 200 to 240 mouldings should be taken every sample batch. This may appear to readers to be a somewhat large number, but at the initial stage it is advisable to err on the generous side, since, it will be recalled, at the moment we are chiefly concerned with the determination of accurate and reliable data from which to make up the control charts.

Frequency of Sample Batch Selection

It very often happens in practice that when a moulding production job has been covered by control in the manner we are about to investigate, the results afforded after only a brief application of the control indicate that the size of the sample batches can safely be reduced from the original figure without any loss of accuracy.

Such a probable reduction in the proportion of sample batch to bulk production will, of course, depend partly upon the closeness of the limits permitted on the moulded articles and partly upon the uniformity with which the components are capable of being consistently reproduced from the mould.

The frequency with which selected sample batches of the above character are taken is also another important matter which has to be carefully thought out beforehand. With some types of plastics mouldings it may prove more economical, particularly of the inspector's time and effort, if a less quantity of components are chosen for each batch, maintaining the percentage relationship to the total production by taking more frequent sample batches. This point, of course, has to be determined in relation to the moulded component and the inspection facilities available, and in this connection only general guidance can be given in this discussion.

With the example we are now considering, in view of the high rate of production (600 per hour), it will be advisable from every angle to make an inspection check each hour throughout the working day. Thus, 200 to 240 components will be checked, and the results graphically represented upon the control chart, once every hour. The same results, as far as control is concerned, would be obtained if sample batches of only 120 components were chosen, each being taken every half-hour instead of hourly.

Generally with most small or medium sized moulding concerns where large inspection staffs and facilities are not available, because of which it is necessary to economize the inspection activities as much as possible, it will usually prove advisable to arrange component inspection by larger batches conducting these at less frequent intervals.

This will be found the best course to adopt for conserving the inspector's time and usually the production from a number of moulds in use at the same time can be adapted to accomplish this end. It will, of course, be obvious that if an inspector has to deal with the output from several multi-impression moulds in simultaneous operation, his activities are likely to become somewhat involved if he has to make checks at very frequent times.

Preliminary Tabulation of Data

In the initial stages, therefore, each hour throughout the daily production run the inspector takes 240 mouldings from those produced in the period. Where

BATCH No.	1	2	3	4	5	6	7	8	9	10	TOTAL DEFECTS	AVERAGE No. PER BATCH $(\bar{p})$	VALUE OF $\bar{p}$	
No. OF DEFECTS PER BATCH	10	9	6	12	8	13	7	6	9	10	90	9	$\frac{p}{240} = \bar{p}$	$\frac{9}{240}$ = .038

REF. No. OF MOULD-ING	RB/7 C/AT	OUTPUT FROM MOULD	600 PER HOUR	SIZE OF SAMPLE BATCH	240	CHECK-ING PERIOD	ONCE PER HOUR	GAUGES TO BE USED	½" DIA. PLUG	NOTES	DATE

Fig. 1.—A convenient form of tabulating preliminary production data.

large quantities of parts have to be handled, as in this present instance, the task of counting out the sample batch may prove tedious. It will often save time if the inspector is provided with a suitable container having a capacity capable of holding the required number of parts when it is full. Alternatively, the requisite quantity could be very quickly determined and isolated by a simple weighing operation. A little attention to this aspect of the inspector's duties will often be the means of helping him to facilitate his duties.

Each individual component of this sample batch of 420 parts is next carefully gauged with the "go"-"not-go" gauge to test the hole diameter. Comparison is also made to the sample test piece to assess the quality of the surface finish.

The quantity of defective mouldings is then counted and the number inserted in the appropriate column of the data table (Fig. 1). Use of such a table as this enables the production data to be very easily dealt with in a straightforward and orderly manner, thereby assisting in the avoidance of errors and oversights during the calculations which are to follow before the control charts can be constructed.

This table is divided into 14 vertical and six horizontal spaces. In the topmost horizontal spacing batch numbers are depicted, each column being numbered so as to provide one space for every set of sample batches selected. In this present case 10 are required.

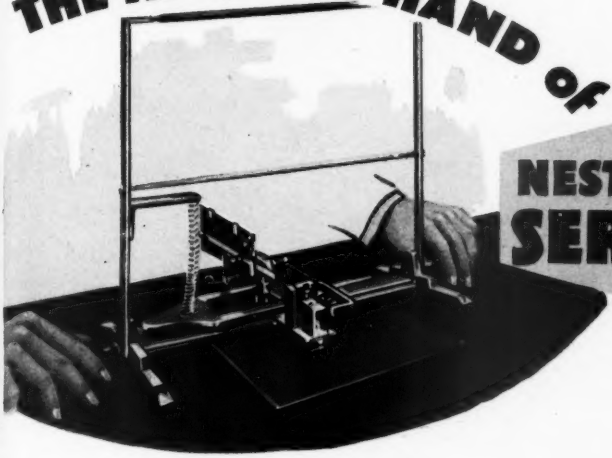
The next horizontal spacing is headed at the extreme left-hand side; "Number of defects per batch." Four horizontal compartments extend across the table wherein the above information can be denoted, thus permitting the table to be used for more than one job, or on the other hand, for a single job of data collection where it is necessary to take more than 10 sample batches.

The three vertical columns remaining at the right-hand side of the table are provided for the insertion of the following essential details:—(a) Total defects from all the batches sampled; (b) average number of defects per batch; and (c) calculated value of "$\bar{p}$."

The bottom horizontal division of the table is sub-divided into several small compartments, as indicated, in order to receive various very relevant pieces of information concerning the test job. It is important that information respecting these matters should be available for the guidance of the inspector making the tests, in order that at this preparatory stage at least there shall be no possibility of error, or omissions arising because of the lack of such essential information.

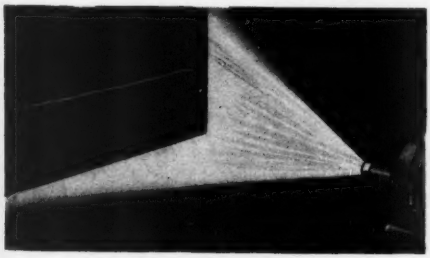
Ten successive sample batches are taken, and every part is gauged in the manner just described, at the rate of one batch every hour. The number of defectives in each batch is counted and entered

THE HELPING HAND of NESTORITE SERVICE



In addition to routine-tests on Nestorite Powders for Moulding properties and to Specifications BS 771, TN 181A, K 110, etc., we employ special tests for other properties. An example is our test for surface undulations, which are magnified and traced by the diamond stylus of an Aerofoil Roughness Recorder on smoked glass—The slide is then projected, as shown.

In this way, surface finish becomes a *known* quantity.



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into the correspondingly numbered vertical column in the table as illustrated.

Referring again to this specimen table it will be observed that columns 1 to 10 have been filled in with the number of defective parts detected. To obtain the average quantity of defects per batch, the total number from all the batches is divided by the number of batches selected. The value of "p" can then be readily obtained directly from this average figure by dividing the latter by 240, i.e., the sample batch quantity of mouldings selected at the outset of the trials.

From our table of results as seen at Fig. 1, it will be noted that a total of 90 defective mouldings have been isolated as being beyond the limits of error in size or finish. This quantity, by the way, results from the checking of 2,400 mouldings. Since the defectives are taken from 10 separate batches, the average number of defects per batch is, therefore, nine. The value of "p" is then readily ascertained by the calculation in the extreme right-hand side column of the table, and is seen to give a value of .038.

This figure, as it stands, can then be used for calculating the relative dispositions of the control datums on the control graph by employing a standard formula to be explained in greater detail later. For plotting actual positions on the graph during a production run, however, it will be necessary to convert this figure into a percentage value, which in this particular instance becomes 3.8 per cent.

The value of factor "p" may also be found directly by calculation, using the following formula or rule, the application of which may often prove helpful and more opportune than making out a complicated table of data:—

$$\frac{\text{Total number of defects}}{\text{Number of batches taken}} \times \frac{100}{\text{Number in one batch}} = \bar{p}\%$$

Calculation of Control Limits for Chart

Having now ascertained the value of "p" for our sample moulding it remains to determine the relative positions of the control datums upon the graph which has to be employed for recording the progress of the production of this moulded article.

These positions are derived by calculations employing the undermentioned formula. The development and statistical basis of this formula are matters rather outside the scope of this present article, but readers wishing to examine the derivation of this, and indeed other quality control formulæ are referred to that excellent booklet "A First Guide to Quality Control for Engineers," which has previously been mentioned in this series. This book not only gives the above formula, but also affords a very useful survey of different methods of applying fraction defective control to automatic machine production.

The formula for determining graph datum positions is:—

$$\bar{p} \pm 3 \times \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

Where $\bar{p}$ is the average fraction defective and n equals the number of components in each sample batch.

Employing this formula and using the value for $\bar{p}$ of .038, which we have already ascertained, we can now find both the upper and lower datum positions for the graph to control this moulding production. The upper control datum location is found by adding to value $\bar{p}$ three times the algebraical quantity beyond the square root sign, whilst the lower datum position is obtained by subtracting the latter quantity from the value of $\bar{p}$

These calculations are carried through at this point so as to guide readers fully in the steps which have to be taken. Taking first the upper limit datum position, we have:—

$$\bar{p} \pm 3 \times \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = .038 + 3 \times \sqrt{\frac{.038 \times .962}{240}}$$

$$= .038 + .039$$

$$= .077 \text{ Upper Limit Position}$$

A similar procedure is employed for calculating the lower limit datum position as follows:—

$$\bar{p} \pm 3 \times \sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = .038 - 3 \times \sqrt{\frac{.038 \times .962}{240}}$$

$$= .038 - .039$$

$$= 0 \text{ Lower Limit Position}$$

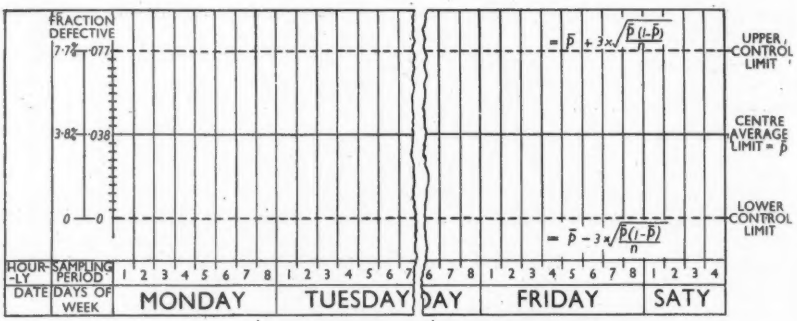

Fig. 2.—Specimen chart for quality control by fraction defective.

The central limit position on the graph is the value of $\bar{p}$, that is, .038.

With the possession of these three measurements or datum relationships, it is now possible for us to proceed with the construction of the control chart for our example moulding.

Fraction Defective Control Chart

At Fig. 2 is shown a specimen chart drawn up on the basis of the foregoing calculations in readiness for dealing with a normal production run from the mould in question.

It is customary with quality control inspectors to employ ordinary squared graph paper for the construction of the control chart, because this is much more convenient to lay out and is easily obtainable Paper to the scale of 10 squares per inch is the most suitable type to use because, as already explained, plottings are made on the graph in percentages of defectives found in respect of a sample batch, and not in actual quantities of such faulty parts.

The graph itself should be made to a convenient scale to permit a reasonably long length of production to be dealt with. In this particular instance, when hourly checks have to be made, the chart is arranged to cover a full week's production from the mould, or, in other words, an average of 25,000 mouldings per week.

In some cases of quality control by fraction defective, it may be more convenient and desirable to have a much larger chart to allow, say, one month's production to be covered. Much depends upon the rate of output, the closeness of the tolerances on the workpiece, the total quantity of mouldings on order, and the amount of deviation normally associated with the moulding operation.

Referring to Fig. 2, it will serve a useful purpose to give a brief explanation of the construction of the chart and the underlying reasons behind the incorporation of certain important features.

This chart comprises three datums or control limits, i.e., the upper, central and lower datum, these being positioned on the vertical ordinate at the left-hand indicated "fraction defective" to the proportions previously ascertained by calculation. It is customary to denote the central limit control by a heavy line, in any suitable colour, so long as it is plainly distinguishable. The upper and lower datums should either be in a completely different colour or marked in heavy, broken lines as shown herewith.

On the vertical ordinate of the graph the distance between the lower and central datums and the central and the upper should be divided into 10 equal spacings, or multiples of 10. The fraction defective is indicated on this vertical ordinate by both percentage and fractional values.

The bottom portion of the chart is split up into a number of compartments,

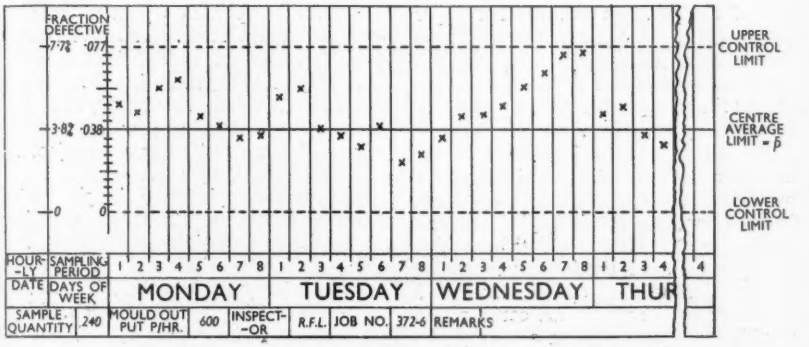

Fig. 3.—Typical control chart, as shown at Fig. 2, here plotted with normal production from a mould.

chiefly to provide spacings representing each day of the week. Each day column is further sub-divided into eight equal spaces, each of which coincides with an interval of one hour during the working day, which period it will be recalled is selected for periodical checkings of the production.

This may be regarded as the basis of all fraction defective charts; it is usual, of course, for the top and bottom margins of such charts to be provided with spacings, into which various other details concerning a particular production job may be inserted as and when necessary for the guidance of the inspector or other interested persons on the moulding shop floor. This latter feature is seen at Fig 3, which shows the identical chart depicted at Fig. 2 for our fraction defective control example moulding, and from this readers will derive a fair idea of the kind of information it is customary to provide on the control chart for the permanent instruction of all concerned with its use.

It will be observed that the chart seen at Fig. 3 is partially filled up with plotted points covering four days' production from the mould, so as to indicate the production trends and the chief features in the compilation and use of such a chart.

In the first place readers will note that the plottings are represented by crosses. Use of the latter is entirely at the discretion of the inspector. The main object is to secure a plainly visible mark and one which will not give rise to confusion or mistake. Some users employ thick black dots, but unless these are made large in size they are apt to be confused with smudges on the graph due to the presence of dirt. It has always to be borne in mind that such charts have to be employed within the works, and usually adjacent to injection or compression moulding machines, and to be compiled by operators who do not always have access for cleaning the parts of the machine nearest to the chart.

Interpreting the Chart

Each plotted point on the chart represents a percentage of defectives. As will be seen, production from the mould remained fairly steady and well under control throughout Monday and Tuesday, since the plottings are more or less equally distributed around the central average limit line. The total percentage of defectives during these first two days of the production run may easily be computed from the chart; in fact, this works out at approximately 4.4 per cent., a figure which very closely approaches the middle average of 3.8 per cent.

On Wednesday, however, a very marked change occurs in the nature of the production as evidenced by the rapid

rise of the plottings towards the upper control limit. At the 7th and 8th inspection checks on this day, the percentage of defective parts has so much increased as to bring the plotted points practically upon the upper datum.

This gives a clear indication to the inspector that something is seriously amiss with the quality of the production, because the product is rapidly passing out of control. Hence, with this warning clearly established, the injection machine is stopped in order to examine the mould in an effort to ascertain the cause of the trouble or departure from accuracy and finish. Corrective action being applied, the machine is again started up.

With the re-commencement of production on Thursday, the quality of the product is once more well under control and at a normal level, as clearly revealed by the positions occupied by the plottings, these again closely approaching the central average datum.

From what has already been said concerning the taking of average defective variations in a product as the factors upon which the control chart is to be based, it will be clear to readers that should the plottings on a chart approach too closely to either the upper or lower control datums, a considerable quantity of defective or even scrapped work may have been produced. It must be remembered in this connection, too, that such a result may arise even if only one plotted point lies outside the control datums.

Therefore, when such a signal of danger is depicted upon the control chart, prompt corrective action must be applied, first, in stopping further production from the mould and, secondly, to conduct a thorough examination of both mould and machine in an endeavour to locate the cause of the discrepancies. It often happens that some variation has unwittingly been made by the operator in the operating methods associated with either the mould or machine, and any investigations made should automatically cover this important aspect of moulding procedure.

Several important points deserve mention at this stage. The first relates to the quantity of mouldings gauged at each inspection check during the production run. It will be recalled that batches of 240 components were selected at the outset of this quality control project in order to determine the control charts.

This same sample batch size should be retained for the routine checkings during the normal production run, at least, for an appreciable period until an adequate amount of experience and guidance has been obtained in respect of the job. After a very substantial proportion of mouldings have been produced, it may be found from reference to the control charts that the range of defectiveness possessed by the fraction defective parts is being held well within the limits imposed by the upper and lower control datums.

When this occurs, smaller sample batches could quite safely be taken or, alternatively, somewhat less frequent checkings could be made. If the former course is adopted, the author would strongly recommend the introduction of a new control chart, in connection with which the datum control positions have been recalculated on the basis of the reduced size of sampling batches.

When installing quality control inspection methods for the first time, the moulding inspector may have to conduct quite an appreciable amount of experimenting, both as to methods of gauging, types of gauges, and to assess the possibilities inherent in the control charts themselves. For this reason some caution is desirable in the initial stages until experience and complete understanding of the principles have been obtained.

Care should also be taken to avoid indulging in complicated forms of gauging or inspection methods for use in conjunction with quality control procedures. The aim should be simplicity in every respect. For example, quality control methods by measurement (as dealt with in earlier sections) should not be adopted if fraction defective methods would serve as well.

(To be continued.)

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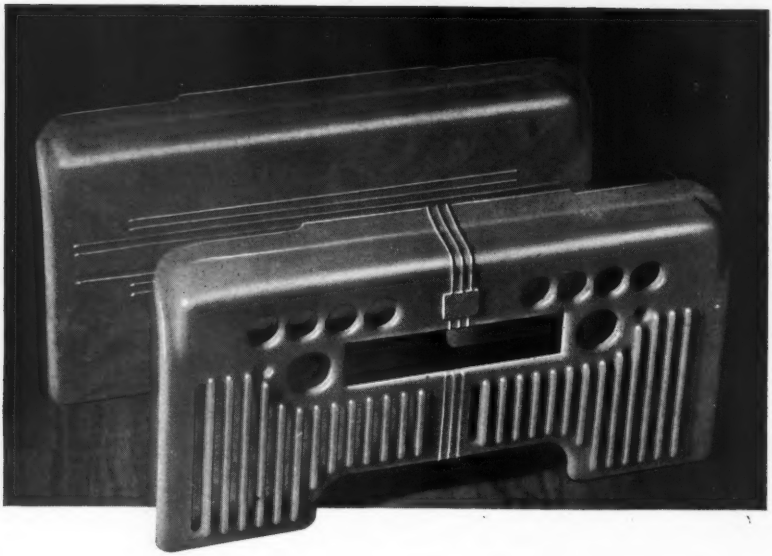

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The Microscopic Examination of Plastic Materials

VII.—Mouldings (Contd.)

By J. H. WREDDEN, F.R.M.S.
(Chief Chemist, Igranic Electric Co., Ltd.)

CONTINUING our study of the oak-flour filled moulding, we see how examination of the sectioned material revealed the presence of particles stemming from the highly thickened fibre vessels, which were rich in a dark-coloured material presumed to be the tannin, as expected of this particular wood. The examination revealed further that these units in the structure were responsible for the existence of greatly weakened points in the general structural scheme, wherever they occurred. The overall tendency is for these tannin-containing components to negate somewhat the otherwise good characteristics of the flour; hence the tensile strength shown by the moulding is not as high as was expected, and in view of the information obtained this is not surprising.

In order that this weakness may be overcome, there are several methods by which the undesirable tannin may be removed, but these are all costly in operation. It is suggested that a partial improvement might be obtained by adjusting the resin components, so that excess formaldehyde is present, during curing, in sufficient quantity to satisfy the demands of the tannin without upsetting the general component balance of the resin composing the matrix. It will be remembered that a similar situation existed in connection with coconut shell flour, where the reactive lignin required a similar excess.

Although the tannin-containing components of the filler are very numerous, they do not by any means constitute a majority, other tissues being represented to a greater extent and consequently helping to reduce the ill effects of the dark particles; another view of the section will make this clear. In Fig. 305 we are presented with a general view at a magnification of 50 diameters, which shows a number of particles composed of ordinary xylem tissue, such as those at A. These, and similar particles, are in horizontal section, as a result of which they are more transparent than those in transverse section; it is this factor which produces the curious effect of there apparently being only a few particles in the mass of resin.

In actual fact it is extremely difficult to detect any portion of this section containing a clear resin mass. The whole structure is very dense and consists of tightly packed wood particles, the majority of which are seen in transverse section, or nearly so. The generally dark

Fig. 305.—Section of oak-filled moulding. Mag. 50 diameters.

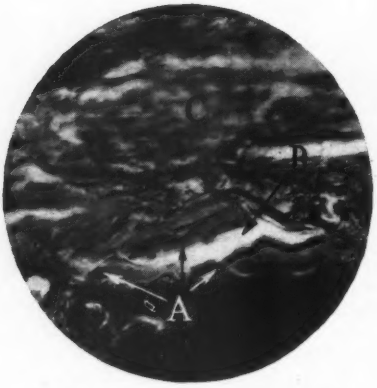

Fig. 306.—Section of oak-filled moulding, showing wood vessels. Mag. 700 diameters.

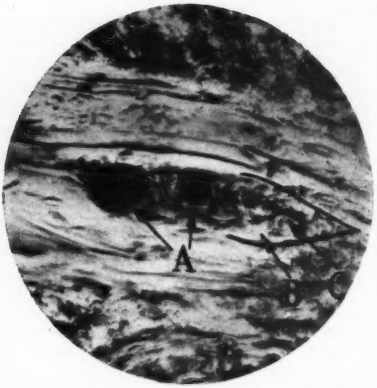

Fig. 307.—Section of oak-filled moulding, showing particle in transverse section. Mag. 700 diameters.

areas, such as that at B, are seen to be constituted in this manner when examined at somewhat higher magnifications. Apart from the foregoing elements in the structure, there also appear here and there, a few fibre bundles which do not contain the dark tannin compound. Two of these are seen at C; they will be discussed subsequently. In general, this illustration shows again the tendency for horizontal orientation adopted by these particles.

As distinct from the thick-walled fibrous elements, the greater portion of the wood composing the filler is made up of vessels possessing relatively thin walls and large bores, and, as expected, these suffer to a considerable extent in the final processing of the powder. Regarding this we see, in Fig. 306, a particle containing some of these elements at a magnification of 700 diameters, wherein the three vessels marked A clearly appear to have been considerably flattened, so much so, indeed, that the lumen is almost completely obliterated; nevertheless they appear to have been filled with resin before this occurred and it can be stated at this point that the particle impregnation of this moulding, in general, is very good.

It must, however, be borne in mind that in all the cases so far studied, and as will be the same in a few of the subsequent examples, the moulding powder was compounded without any pigment, so that there exists very little tendency for blocking the entry of the fluid resin into small spaces, which, as has already been pointed out, probably exists in cases where granular pigments are used. In this case the only factor tending to bring about this condition would be premature closure of the ends of the vessels, thus trapping air in the interior. As this has not been deleted in the specimen under consideration, it is probable that it would be the exception rather than the rule. The white area marked B is a crack in the section, similar to those previously seen, and it will be noted that this is not a dark particle and, therefore, the actual vessels have not been fractured, but instead the gap occurs between them in much the same way as was encountered in the flax- and beech-filled materials.

The rest of this filler particle, shown at C, is unfortunately out of focus and, therefore, it is impossible to form any conclusion as to the state of the vessels therein, but it may be taken that visual examination under the microscope indicates that the great majority of these vessels are seen to have collapsed in a similar manner.

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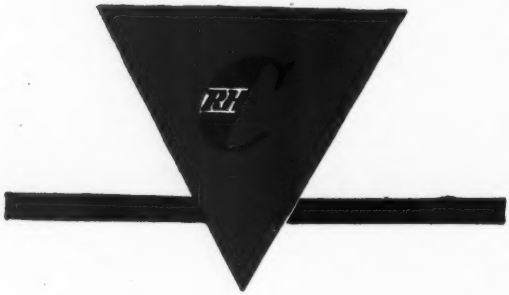

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A curious fact relating to the distortion of the wood structures in this oak-filled moulding is brought to light in this examination by the appearances of the medullary rays when seen in transverse section (or more properly when the particle is seen in tangential section). These structures appear to suffer less in the way of collapse than the vessels of the xylem. In Fig. 307 we see a particle so sectioned, at a magnification of 700 diameters, wherein it will be noted that the larger cells marked A show no sign of this form of distortion. On the other hand, the smaller cells of this ray, in the area marked B, are so distorted as to be all but indistinguishable.

The apparently anomalous condition in this structure exists by virtue of the fact that all the cells in a medullary ray are thin-walled by comparison with the xylem elements, and, therefore, the larger cells may be expected to show signs of collapse earlier than the small cells. It is also self-evident that the large cells appear to be filled with the now familiar dark material, whereas the smaller cells are not so filled, with the exception of the small group at C, which, as in the case of the large ones, do not appear to have suffered to the same extent as those surrounding them, under the influence of the moulding conditions. This effect is significant as it would appear that the dark material, or the tannin resin complex (if it be such), reaches a point where immobility ceases with the production of a hard mass, at a much earlier period than the rest of the resin and, therefore, the cell is filled with a solid and can resist the effects of the moulding pressure.

If this is so, it would seem that the presence of the tannin in some way increases the tendency for the resin to flow into the cell and fill it, for it will be appreciated that this latter must occur rapidly in order to bring about the effect seen. In other words, the filling of the cells in the medullary ray must occur before any of the other vessels is filled. On the other hand, if the tannin-resin complex resulted in a very rapid setting material, a similar condition could be produced, but in view of the collapsing of the unfilled xylem vessels, this latter is somewhat doubtful, as the vessels are collapsed to such a degree as to preclude the possibility of there being any resin in the bore, or rather, what is left of it.

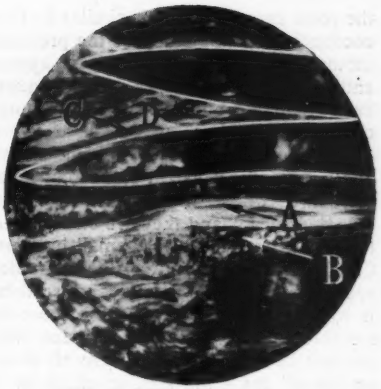

Fig. 308.—Section of oak-filled moulding showing resin structure. Mag. 1,400 diameters.

It will be seen, therefore, that the collapse must occur in the very early stages of the moulding cycle, before a fluid pressure is built up outside the vessels. This means that it must happen before the resin is fluid, otherwise the collapse would be limited by the development of air, or gas, pressure inside the vessel, which is equal to the fluid pressure outside. This limiting pressure need not necessarily be the maximum developed during moulding, as evidenced by the partial impregnation of some vessels, resulting in bubbles being trapped in the box. However, all this should be regarded as being purely theoretical in nature, and not capable of being substantiated by experimental evidence at the moment. That these conditions exist there is no doubt, but the factor or factors which become operative during moulding, to cause the effects seen, are still somewhat obscure; until this is elucidated, we are forced into theoretical assumptions.

Further consideration of this illustration shows the granular appearance of

the resin masses, which is similar to that encountered in the study of the previous mouldings. Here, again, this is apparently due to the presence of large numbers of minute bubbles, which are more clearly seen when examined at close quarters, as in Fig. 308, which shows another wood particle at 1,400 diameters. Here are two resin masses filling two xylem elements, and they are clearly seen to contain numerous very small bubbles. Comparing these with the bubbles encountered in the beechwood section, it will be noticed that whereas those in this latter were of differing size, the bubbles in the present case are all more or less of the same size, resulting in a more uniform texture being imparted to the resin mass.

The reason for this would appear to lie in the small space occupied by the resin, for it is evident from this photograph that the vessels concerned are similar to the large vessels previously seen in transverse section, and also in a similar condition of collapse; in this particular instance, however, it does appear as if the units had collapsed to the same degree. This would indicate the filling of the vessel before it was able to reach this degree of collapse; hence at the point seen it may be assumed that the air was pushed out of the tube and fluid took its place, which was subsequently hardened in situ.

It will be appreciated that we again have a particle in tangential section, in which portions of two medullary rays are distinguishable. These are seen to occupy the area marked C and D, and in each case the cells will be seen to be filled with the dark material, with the exception of one cell in the ray marked C. This appears to be filled with clear resin, and in view of its still undistorted appearance, it would appear that there exists something of a contradiction to previously expressed views, for if the dark material were responsible for the lack of distortion in those cells filled with it, we would expect the appearance of collapse in cells not containing this substance.

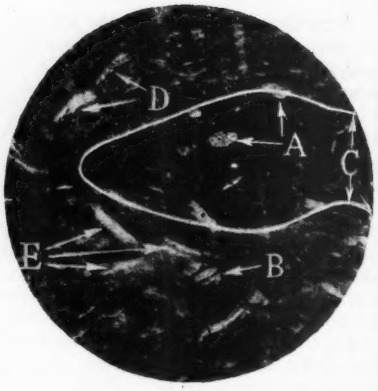

Fig. 309.—General structure of oak-filled moulding showing cracks in dark particles. Mag. 40 diameters.

It might be argued, however, that presuming the dark material to fill the cell and set rapidly (as previously suggested), then, in the circumstances illustrated, these would already be solid and thus afford some degree of mechanical support for the cell under consideration, which might be expected to be held open while the resin flowed into it. The presence of the dark cells immediately above the clear one, situated in area D, should also be taken into account as they will undoubtedly influence the conditions appertaining to the whole. Without more evidence it is impossible to state the basic cause of this seeming anomaly.

Up to the present we have considered in some detail the fibrous elements containing the tannin, and the xylem elements proper, which do not contain tannin. We give the name "fibrous elements" to bundles of units having greatly thickened walls, and which, in appearance, are very like typical true fibre bundles. However, these elements exist in the woody portion of the oak and, indeed, to some extent, in the majority of hardwoods, their great strength being the chief component in those conferring this property on the wood as a whole.

It will therefore be appreciated that

this type of element, when encountered in a moulding, is somewhat indicative of the presence of hardwood, and, indeed, when coupled with the dense black colorations, such as in the example under consideration, they may be taken as indicating the wood to be either oak or one of the species rich in tannins. But it would in all probability be oak-wood, as this is the most readily available material which would be likely to produce the result shown. However, all these so-called fibrous elements do not contain tannin.

In order that this may be shown, suppose we re-examine the section at low magnification, as seen in Fig. 309 at 40 diameters. In the centre of this photograph we see two particles of an apparently different type from those previously encountered. At this magnification they are clearly seen to resemble fibre bundles. Another similar particle is seen at B, but the structure of this is not quite clear, although there is a distinct resemblance to the other two particles. We will, however, return to discuss this shortly; at the moment it is expedient to examine the photograph as a whole, because it shows what might be a good example of channel formation due to segregation being brought about by difference in particle size and differential curing.

Thus it will be seen that in the area outlined and marked C, the majority of the particles are the now familiar dark variety; further, the general particle size is smaller than that for the area outside. The curious shape of area C will be noticed, and presuming that the mass at this point solidified earlier, and the remainder for reasons already stated, it will be appreciated that there will come into existence a relatively large solid body of the shape indicated, which would proceed to function as a single large particle, producing flow interruption and turbulence around itself in much the same manner as was seen in the case of the flex shive moulding.

That this has actually appeared to take place may be seen by the orientation of the particles in the outer area, where there are distinct signs of redirection around the point of the area C, brought into evidence by the particles marked D and E, which are seen to have been orientated at an angle to the general longitudinal orientation roughly corresponding to the angle of the point. The most puzzling factor in this structure is whether the turbulence is due to the shape of the first appearing solid mass, or whether the shape of this mass was developed by the flow of the outer material around it.

It is highly probable that a combination of both produces this result, for it is reasonable to suppose that the mass indicated by the area C was originally built up from a small core and as it developed in size, so its shape would be influenced by the more fluid resin mass flowing past and around it. When the mass C was fully developed, the resin would continue to flow for some time, with the result evident in this photograph. It might be argued that this illustration is of one spot in the section where the configuration of the particles happens to be thus, but in contradistinction to this it is possible to find many such arrangements all over the section, although not always so clear cut; the particular example was chosen for its clarity.

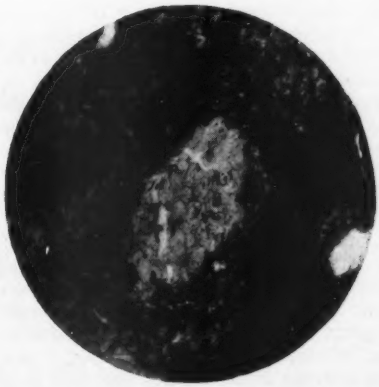

Fig. 310.—Structure of oak-filled moulding showing fibres. Mag. 145 diameters.

So much then for the general characteristics of the section at this point. Now let us examine a little more closely the particles marked A. From the appearance in Fig. 309, the particle in the centre shows distinct fibre bundle characteristics, and on examining it at a magnification of 145 diameters, as shown in Fig. 310, it is seen to be composed of vessels possessing very thick walls which are characteristic of the wood. The point of main significance, however, is the lack of colouring matter which shows the possibility of the existence of this type of vessel, as against the examples where the colour is present; numerous individuals of this nature are seen in the illustration.

Unfortunately, the uncoloured fibre bundles are only few in number, in consequence of which they cannot mitigate the effects of their coloured prototypes to any great extent, for it will be appreciated that if the uncoloured units were present to any great extent, then the weakening effect of the coloured types might be expected to be offset to some degree. In the immediate vicinity of this unit will be seen a relatively large mass of the normal xylem elements, which have suffered considerable distortion in the processing. This is to be expected rather than otherwise, and serves to illustrate the great resistance to those conditions possessed by the thick-walled vessels in the, so-called, fibre bundle.

In general, this oak-filled moulding has proved a most interesting study, and in the foregoing examination, brief as it is, there has been much information brought to light regarding the behaviour of the wood when used as a filler for moulding powders. In comparing it with those previously examined, the most interesting phenomenon not encountered in the other samples was the effect of the presence of what is presumably the tannin existing in the filler. If the conclusions drawn on this assumption are correct, it would appear that there exists a useful material in this latter substance, provided it can be brought under control and used as a means for procuring a more rapid cure in phenolic.

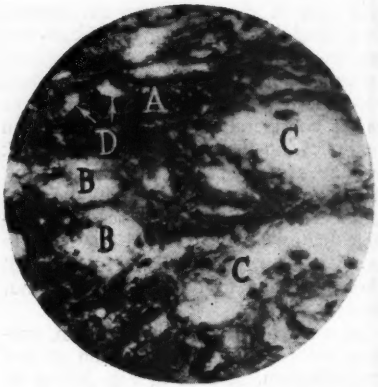

Fig. 311.—Leather-filled moulding : general structure in transverse section. Mag. 26 diameters.

In order that this may be accomplished, it seems likely that the tannic acid will have to be regarded as an additional ingredient in the formulation, requiring a corresponding adjustment in the formaldehyde ratio, but as to whether its incorporation will produce the best results when carried out in the initial resin condensation, or on the rolls, remains to be proved by experiment. This method is the only way in which its utility may be assessed at all, and until the results of such work are available, the question must remain in the realms of conjecture. However, there is no doubt that the effect seen is produced by some substance, whether it be tannic acid or not, which was not present in the two previously examined specimens. As these are known to possess little, if any, tannin, and the oak is known to be rich in it, the conclusions arrived at are to some extent justified.

Apart from this it was seen that the filler showed a tendency to orientate itself in a manner similar to the others; in this case, however, this tendency was not so pronounced, chiefly because the filler possessed a better variability index. Nevertheless, the curious effects due to segregation, not in this case to differences in particle size, but rather to differences

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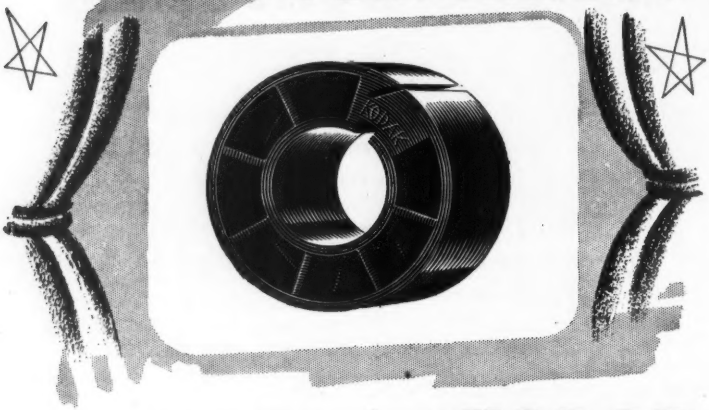

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in viscosity, at any given time during the fluid stage, are illuminating; they point the way to the necessity for a more detailed knowledge of the chemical composition and resultant effects of organic fillers in general.

As in dealing with oak-filled mouldings, we have seen that effects are, apparently, produced from materials other than the pure wood tissue, it is appropriate at this point to digress somewhat from our main theme of examination of mouldings filled with organic fibres of vegetable origin and examine one using leather powder.

Leather, in its various forms, is animal skin which has undergone treatment with tanning reagents, resulting in the coagulating of the proteins. Fig. 311 shows a transverse section of a leather-filled moulding at a magnification of 26 diameters. The point of most general interest in this photograph is the indefinite nature of the structure, for whereas there is very little tendency to a regular structure, indicating a certain degree of homogeneity, there does exist definite evidence showing a strong tendency towards heterogeneity. Although the compact structure, as seen at A, consists of a mass of leather particles, the majority of which are partially fused, there also exist voids in the material, as seen at B, while at C are large masses of clear resin.

In view of the fact that leather consists mainly of precipitated protein fibres, there will be an appreciable degree of pyrolysis in the curing, resulting in the many products obtained by so treating this material. As a result of this, the appearance of pockets of gas and the segregation of masses of the remaining fibres, due to their fusing with one another, resulting in isolated resin masses, are rather to be expected than otherwise. The appearance of these voids, due to gas formation, occurs abundantly throughout the structure of this material; the voids are of various shapes and sizes, from microscopic dimensions to indeterminate size, such as the two shown at D, up to the larger sizes already mentioned.

As a result of this, it is not surprising that the whole structure is "honeycombed" with these gas pockets and somewhat resembles a sponge; therefore, as may be expected, the tensile strength suffers accordingly. Added to this is the embrittlement of the leather itself, due to the heat, which adds its effect to the degradation of this property. At the same time a study of the resin masses brings forth the interesting information that in a large number of cases much crazing is to be found. In Fig. 312 two such masses are seen at 26 diameters, and the degree of crazing is self-evident. In addition to this, it will be seen that the masses are not complete, but in view of the treatment necessary to produce the section it is probable that the gaps are due to pieces of resin having fallen out.

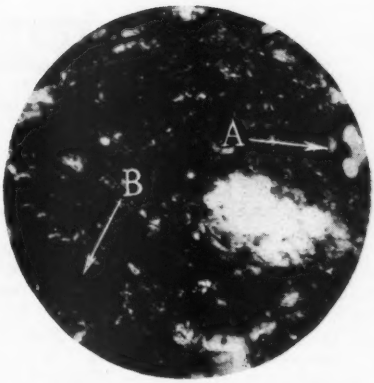

Fig. 312.—Leather-filled moulding showing "crazing." Mag. 26 diameters.

Fig. 312 also affords a good illustration of the general conditions to be encountered in the leather masses and the manner in which the structure is liberally supplied with voids. A very good example of the method by which these gas pockets are generated is shown at A, where a particularly dense leather particle is seen in the process of fusing and giving rise to a void, beside which is seen the commencement of another void, in the shape of a bubble just forming; this latter condition is also evident in the particle marked B.

(To be continued)

PATENT REVIEW

The following abstracts have been made from specifications at the Patent Office, with the permission of the Controller of H.M. Stationery Office. Complete specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1/- each.

B.P. 597,728. Application date: 24.8.45. Accepted: 2.2.48.

Improvements in Apparatus for Coating and/or Impregnating Threads with Synthetic Resins. J. A. Lodge.

Apparatus for the simultaneous treatment of a number of cotton or other threads with synthetic resins (polyvinyl chloride or copolymers).

B.P. 597,783. Application date: 27.8.45. Accepted: 3.2.48.

Improvements relating to the Manufacture of Rubber-like Substances. J. R. Whinfield and W. K. Birtwistle.

Improving the physical and chemical properties of highly polymerized N-phenyl diethanolamine adipate by compounding with at least one substance selected from the group consisting of elements of group II of the periodic system (and in particular their oxides, hydroxides, carbonates, borates and polymethylene dicarboxylates).

B.P. 597,786. Application date: 27.8.45. Convention date: (U.S.A.) 18.5.45. Accepted: 3.2.48.

Packages. To: Wingfoot Corporation.

Multi-unit package consisting of a plurality of units of a material which emits carbon dioxide. Each unit is enclosed in a film, which is permeable to carbon dioxide. The whole assembly is enclosed in moisture-proof, gas-impermeable film (inner layer vinyl film, outer layer regenerated cellulose).

B.P. 597,833. Application date: 1.8.45. Convention date: (U.S.A.) 2.8.44. Accepted: 4.2.48.

Improvements in or relating to Polymerization Products to Ethylene. To: E. I. Du Pont de Nemours and Co.

Decreasing the solubility of saturated and soluble solid polymers and interpolymers of ethylene by mixing an organic compound capable of generating free radicals when subjected to heat (organic peroxide, a metal alkyl derivative, etc.) and heating the resultant mixture.

B.P. 597,932. Application date: 17.8.44. Accepted: 6.2.48.

Improvements in or relating to the Manufacture of Moulded Articles. W. I. Jones. To: C. D. Patents, Ltd.

Moulding composition prepared by heating an intimate mixture of finely divided coal and a modifier (finely divided pitch) at temperatures between 240-400 degrees C.

B.P. 597,997. Application date: 27.8.45. Accepted: 9.2.48.

Improvements in Apparatus for Injection Moulding of Thermoplastic Materials. A. Cretin. To: Thurgar Bolle, Ltd.

Relates to the design of injection moulding machines (injection cylinder) for cellulose acetate and other thermoplastic materials.

B.P. 598,023. Application date: 29.8.45. Accepted: 9.2.48.

Improvements in or relating to Compositions Suitable for Use in the Adhesive Bonding of Surfaces or Methods of making the same. L. E. Puddefoot and A. M. Hall. To: B.B. Chemical, Ltd.

Adhesive composition consisting of Neoprene latex, a tackifyer (saponified natural resin-gum rosin) and an agent which prevents undue stickiness (Neoprene dispersion).

B.P. 598,055. Application date: 19.7.44. Accepted: 10.2.48.

Plastic Composition. To: Shawinigan Chemicals, Ltd.

Composition containing polyvinyl acetate, a wax (paraffin, beeswax, carnauba or candelilla wax) and a rubber substance (Hevea rubber, isobutylene or isoprene).

B.P. 598,069. Application date: 15.3.45. Convention date: (U.S.A.) 14.11.44. Accepted: 10.2.48.

Nuclear Substituted Dimethyl Styrenes and their Production. To: Dominion Tar and Chemical Co., Ltd.

Production of dimethyl styrene from asymetric dixylyl ethane by heating the latter to at least 350 degrees C. in the presence of hydrated aluminium silicate as catalyst.

B.P. 598,103. Application date: 22.10.45. Accepted: 10.2.48.

Improvements relating to the Catalytic Hydrogenation of Olefins. To: Standard Oil Development Co.

Relates to the catalytic hydrogenation of polyisobutylenes.

THE FLEXURAL STRENGTH OF MONSANTO Lustron

POLYSTYRENE MOULDING CRYSTALS

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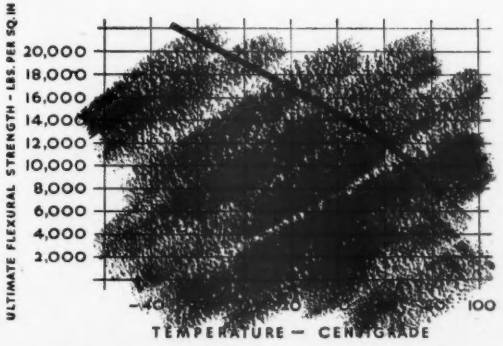

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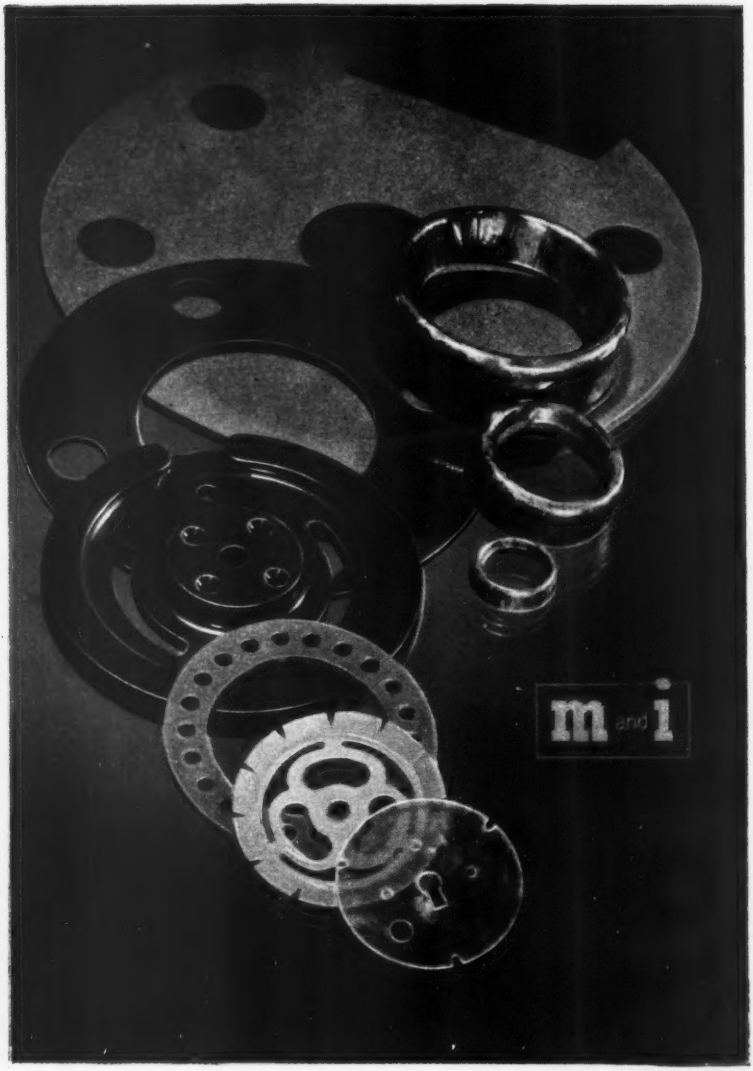

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B.P. 598,140. Application date: 31.8.45. Convention date: (U.S.A.) 20.10.44. Accepted: 11.2.48.

Improvements in Method of Preparing Aqueous Dispersions of Synthetic Resins. To: Dispersions Process Inc.

B.P. 598,143. Application date: 31.8.45. Accepted: 11.2.48.

Improvements in or relating to Decorative Beading. A. Y. Dalziel. To: Imperial Chemical Industries, Ltd.

Decorative beading made from plasticized vinyl chloride polymers or interpolymers.

B.P. 598,257. Application date: 18.5.45. Convention date: (U.S.A.) 27.6.44. Accepted: 13.2.48.

Improvement in Vinyl Resin Suspensions. G. M. Powell and T. E. Mullen. To: Carbide and Carbon Chemicals Corp.

Refers to non-aqueous stable dispersions of polymers or copolymers of vinyl chloride.

B.P. 598,361. Application date: 9.1.45. Accepted: 17.2.48.

Improvements relating to Laminated Sheet Materials. E. H. G. Sargent.

Preparation of laminated sheet materials from cellulose material and synthetic resins, by impregnating or coating the fibrous material with quarternary ammonium compounds, sulphonium or phosphonium compounds and coating or impregnating the water-repellant material so formed with a thermosetting material, subsequently forming laminates.

B.P. 598,378. Application date: 1.6.45. Convention date (U.S.A.): 3.6.44. Accepted: 17.2.48.

Improvements in and relating to Glass Fibre Sheet Material. To: The British Thomson-Houston Co., Ltd.

Manufacture of dielectric sheet materials by making a pulp in water of a mixture of 60-98 per cent. glass fibres with 40-2 per cent. cellulose fibres, preparing sheets from the mixture and impregnating them after drying with polyvinyl carbazole.

B.P. 598,395. Application date: 4.10.45. Accepted: 17.2.48.

Pliable Sheet Material for Packaging Purposes and a Process for the Production of Packages therefrom. L. Rado.

Production of packages from a pliable sheet provided with a thermoplastic adhesive in the form of parallel intersecting lines and sealing the overlapping edges by a heated tool.

B.P. 598,416. Application date: 3.9.45. Accepted: 18.2.48.

Improvements relating to the Manufacture of Rubber-like Substances. J. R. Whinfield and W. K. Birtwistle.

Improving the physical and chemical properties of highly polymerized esters of di-alkylol arylamines by incorporating a polymer of formaldehyde and heating until an insoluble and infusible product is obtained.

B.P. 598,456. Application date: 4.9.45. Convention date (U.S.A.): 14.9.44. Accepted: 18.2.48.

Improvements in and relating to Pressure Sensitive Adhesives. W. L. Nelson and W. N. Morris. To: Johnson and Johnson (Gt. Britain), Ltd.

Pressure sensitive adhesive comprising an elastomeric base including polyvinyl normal butyl ether of high molecular weight and factice made from a vegetable oil.

B.P. 598,464. Application date: 5.9.45. Convention date (U.S.A.): 5.9.44. Accepted: 18.2.48.

Improved Fibres of Ethylene Polymers. To: E. I. Du Pont de Nemours and Co.

B.P. 598,506. Application date: 31.10.45. Accepted: 19.2.48.

Improvements in or relating to the Manufacture of Resin Emulsions. J. J. P. Staudinger and D. L. Cleverdon. To: Distillers Co., Ltd.

Manufacture of stable emulsions of polyvinyl esters, polyacrylic and polymethacrylic esters by incorporating a stabilizer consisting of one or more fatty alcohols containing 10-20 carbon atoms in the molecule, an emulsifying agent and a surface-tension reducer (sodium salt of dioctyl sulphosuccinic acid).

B.P. 598,533. Application date: 13.7.43. Convention date (U.S.A.): 6.6.42. Accepted: 20.2.48.

Improvements in or relating to Process for the Production of Melamine. To: American Cyanamid Company.

B.P. 598,558. Application date: 15.3.45. Convention date (U.S.A.): 14.11.44. Accepted: 20.2.48.

Polymerization of Dimethyl Styrenes. To: Dominion Tar and Chemical Co., Ltd.

B.P. 598,562. Application dates: 25.4.45 and 23.4.46. Accepted: 20.2.48.

Improvements in or relating to the Manufacture of Plastics from Alginates. E. G. Millatt. To: Cefoil, Ltd.

Production of moulded plastics by taking a moulding powder comprising a water-insoluble metal alginate, an ammonium

yielding ingredient and enough water to make the mixture mouldable, adding a filler when so desired, moulding under heat and pressure and eliminating the ammonium alginates from the product.

B.P. 598,576. Application date: 26.7.45. Accepted: 20.2.48.

Improvements in Printing Inks which include Synthetic Resins in their Composition. To: F. G. Levey Co., Inc.

B.P. 598,587. Application date: 5.5.44. Accepted: 23.2.48.

Improvements in or relafing to the Heating of Dielectric Materials. A. J. Maddock. To: Standard Telephones and Cables, Ltd.

Equipment for the heating of dielectric materials by high-frequency energy. The electrodes are made of electrically conducting material of high resistivity and become hot by the passage of high-frequency current.

B.P. 598,602. Application date: 23.5.45. Convention date (U.S.A.): 12.8.42. Accepted: 23.2.48.

Method of Producing Copolymer Resins and Products therefrom. P. H. Rhodes.

Refers to the manufacture of copolymers oy reacting a monohydric phenolic body and an aldehyde or a polyhydroxy phenol body and an aldehyde.

B.P. 598,637. Application date: 18.9.45. Accepted: 23.2.48.

Process for the Production of Metal Covered Plastic Articles. L. Rado.

B.P. 598,652. Application date: 24.9.43. Accepted: 24.2.48.

Improvements in or relating to Transparent Adhesive Tapes or Sheets, and Articles and Signs including such Adhesive Tapes or Sheets. To: Minnesota Mining and Manufacturing Co.

B.P. 598,777. Application date: 10.9.45. Accepted: 26.2.48.

Improvements in or relating to the Production of Polymeric Materials. D. Brundrit and J. A. D. Hickson. To: Imperial Chemical Industries, Ltd.

Polymerization or interpolymerization of vinyl compounds in the presence of an emulsifying agent, a peroxy compound and a copper salt. Polymerization is carried out in an aqueous phase in the presence of small amounts of oxygen.

B.P. 598,778. Application date: 10.9.45. Accepted: 28.2.48.

Organo-Silicon Compounds. H. J. Emeléus and S. R. Robinson. To: Imperial Chemical Industries, Ltd.

B.P. 598,785. Application date: 10.9.45. Accepted. 26.2.48.

Improvements in the Manufacture of Moulded Articles from Vegetable Material. C. L. Walsh, B. A. Adams and R. C. Barker. To: A.S.P. Chemical Co., Ltd.

Manufacture of moulded articles from vegetable matter (sisal flesh, sawdust, woodshavings, flax shives, peat, etc.) by chlorinating the vegetable matter, subsequently removing excess chlorine gas or halogen compounds followed by a drying operation, grinding and sieving of the material. A thermosetting resin is added as a binder and hexamine, zinc stearate or triphenylphosphate as a plasticizer. Moulding is carried out at elevated temperatures under pressure.

B.P. 598,820. Application date: 12.9.45. Convention date (U.S.A.): 15.9.44. Accepted. 26.2.48.

Improvements in the Drawing of Filaments of Synthetic Linear Polyamides. To: E. I. Du Pont de Nemours and Co.

Production of improved Nylon filaments by passing said filaments through a heating zone to raise the temperature of the filaments to at least 80 degress C., but below their melting point. During this operation the filaments are under drawing tension; they are thus permanently increased in length. Cooling is subsequently effected by passing through a water bath. Filaments so treated are claimed to be of particular value for the manufacture of all kinds of brushes.

B.P. 598,821. Application date: 12.9.45. Convention date (U.S.A.): 21.9.44. Accepted. 26.2.48.

Improvements in Paint Brushes with Synthetic Filaments. E. I. Du Pont de Nemours and Co.

Paint brushes with tapered Nylon filaments. Improved paint pick-up is claimed.

B.P. 598,822. Application date: 12.9.45. Convention date (U.S.A.): 12.9.44. Accepted. 26.2.48.

Polymerization Products. To: E. I. Du Pont de Nemours and Co.

Polymerization of compounds having monolefinic unsaturation in the presence of an azine (benzalazine or diphenylketazine) preferably in the presence of a non-polymerizable liquid medium.

B.P. 598,857. Application date: 21.9.45. Convention date (U.S.A.): 26.9.44. Accepted: 27.2.48.

Improvements in and relating to Polymers and Copolymers of Acenaphthylene. To: The British Thomson-Houston Co., Ltd.

Production of acenaphthylene polymers

or copolymers from acenaphthylene and monomeric compounds containing a vinyl group by reacting a mixture of the above, dissolved in benzene or chlorobenzene in the presence of a catalyst (boron fluoride) at low temperatures.

B.P. 598,871. Application date: 21.9.45. Convention date (U.S.A.): 30.12.44. Accepted: 27.2.48.

Improvements in Oil Phase Polymerization. To: United States Rubber Co.

B.P. 598,890. Application date: 9.12.43. Accepted: 1.3.48.

Improved Polymerization Process. J. J. P. Staudinger and M. D. Cooke. To: The Distillers Co., Ltd.

Polymers or copolymers of vinylidene chloride and vinylchloride made by subjecting a two phase emulsion or dispersion of the polymerizable monomers to the action of heat and light in the presence of a catalytic per-compound and an aliphatic carboxylic acid.

B.P. 598,896. Application date: 18.9.44. Accepted: 1.3.48.

Improvements in Foot Arch and like Supports. W. M. Scholl. To: The Scholl Manufacturing Co., Ltd.

Plastic foot support having an upper member shaped in keeping with the surface of a foot. The lower member is of a stronger material.

B.P. 598,910. Application date: 17.3.45. Accepted: 1.3.48.

Improvements connected with Electric Hot Plates or the like for Heating Moulds containing Plastic Material or for other Purposes.

B.P. 598,925. Application date: 17.7.45. Accepted: 1.3.48.

Improvements in or relating to Low Temperature Polymerization of Hydro Carbons. To: Standard Oil Development Co.

Copolymerization of substituted styrenes and polyolefines (Alphamethyl styrene with isoprene or two-methyl pentadiene).

B.P. 598,926. Application date: 30.7.45. Convention date (U.S.A.): 21.7.44. Accepted: 1.3.48.

Improvements relating to High Frequency Electrical Heating. E. Mittelmann.

Automatic tuning device for high frequency generators consisting of systems which mechanically operate position of coils and condenser vanes simultaneously.

B.P. 598,961. Application date: 1.3.45. Convention date (U.S.A.): 25.2.44. Accepted: 2.3.48.

Improved Resinous Compositions and Infusible, Insoluble Resinous Products obtained therewith. To: Monsanto Chemical Co.

Refers to compositions comprising a polyvinyl acetal (polyvinyl butyraldehyde-acetal), a partial ester of a polyhydric alcohol (glycerin) with an unsaturated aliphatic acid (glyceryl mono-12-hydroxy-9-octadecenonte) and a phenol-formaldehyde reaction product. The latter is being incorporated while in the soluble state.

B.P. 598,982. Application date: 9.7.45. Accepted: 2.3.48.

Improvements in or relating to Adhesives and Hardeners for Resinous Materials. D. N. Davies and F. S. Deutsch. Cellomold, Ltd.

Hardener for formaldehyde deficient resorcinol, formaldehyde resins comprising paraformaldehyde, magnesia and woodflour.

B.P. 599,023. Application date: 16.7.45. Accepted: 3.3.48.

Improvements in or relating to Liquid Containers, and Methods of Making the same. E. T. Court and L. Shakesby. British Insulated Cables, Ltd., and Imperial Chemical Industries, Ltd.

H.F. welding of thermoplastic skins of fuel tanks, etc. Two rollers or pads are applied. The path of H.F. current is:—Roller, plastic, former (metal), plastic, roller.

B.P. 599,054. Application date: 24.10.45. Convention date (U.S.A.): 26.1.45. Accepted: 3.3.48.

Improvements in or relating to Moulding Compositions and Articles thereof. W. E. Gloor. To: Hercules Powder Co.

Refers to cellulose acetate moulding powders of high impact strength at very low temperatures.

B.P. 599,055. Application date: 20.10.45. Patent of addition to B.P. 583,349. Accepted: 3.3.48.

Improvements in the Colouration of Textile Materials of Cellulose Esters or Ethers. H. C. Olpin, E. Stanley and T. Jackson. To: British Celanese, Ltd.

Process for the colouration of cellulose ester-or-ether textiles by mechanically impregnating the material with a solution of a dye in a mixture of water, ethyl alcohol and an inorganic thiocyanate which acts as a swelling agent for the cellulose ester or ether, thereafter steaming the material.

BAKELITE, LTD.—The annual general meeting of Bakelite, Ltd., was held at the company's head office, 12, Hobart Place, London, S.W.1, on June 24, when the chairman, Sir James Swinburne, Bart., F.R.S., presented the accounts and directors' report for the year 1947.

New articles of association were adopted, which removed previous restrictions on transfer of shares, having the effect of converting the company into a public company. The authorized capital of the company was increased by £150,000, making the nominal capital £1,000,000.

Mr. H. V. Potter, managing director, said that the new vinyl project, together with other expansion programmes, was under way, and a new site had been acquired adjoining the present factory at Aycliffe, Co. Durham. The phenolic plastics expansion at Aycliffe is now taking shape, and some of the new equipment will come into operation shortly.

A considerable interest has been taken in a new company to manufacture synthetic phenol.

MACHINE TOOLS.—The May issue of "Modern Times," the monthly journal of the E. H. Jones (Machine Tools), Ltd., Export Organization, contains a detailed account of many of the E.H.J. exhibits which will be seen at the Machine Tool and Engineering Exhibition to be held at Olympia, London, August 26 to September 11 next.

THE SWEDISH PLASTICS FEDERATION (Svenska Konsthartsföreningen) have removed to Karlavägen 43 II, Stockholm, as from July 1.

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Leaves from a Moulder's Notebook

This is the nineteenth in a series of notes by the B.I.P. Development Department on the problems of the moulder and designer. Nos. 1—12 in this series are now available in booklet form and B.I.P. will be pleased to send a copy of this and subsequent notes on request. Comments and enquiries are welcome.

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Notwithstanding this, one is aware that the feed of a mould often fails to get adequate consideration both in the design and mould making stages.

In No. 16 of this series, a workable rule was described for gates for medium-sized mouldings but none was given for feeds, although guidance regarding them was attempted. This is because (1) the feed is more important and more critical than the gate, making a rule more difficult to define; (2) it is three-dimensional and not two-dimensional like the gate; and (3) its length and position, unlike that of the gate, varies with each mould made.

The only rule that can be laid down is that the length of the feed must be as short as possible—hence the greater success of the auxiliary plunger mould (*see Fig.* 1) compared with the stalk-type, integral (*see Fig.* 2) and certain other moulds such as the separate pot type (*see Fig.* 3) in the case of difficult moulding jobs.

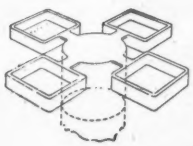

Fig. 1.
Auxiliary Plunger Mould

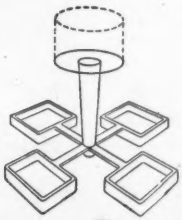

Fig. 2.
Stalk-type Integral Mould

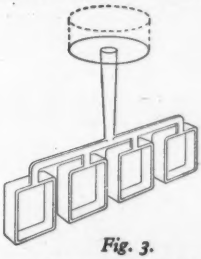

Fig. 3.
Separate Pot Mould

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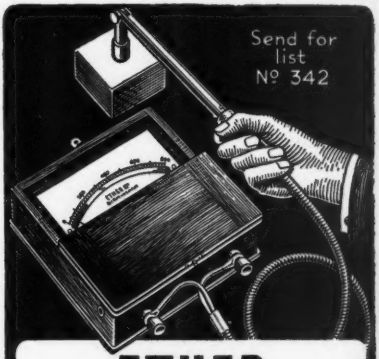

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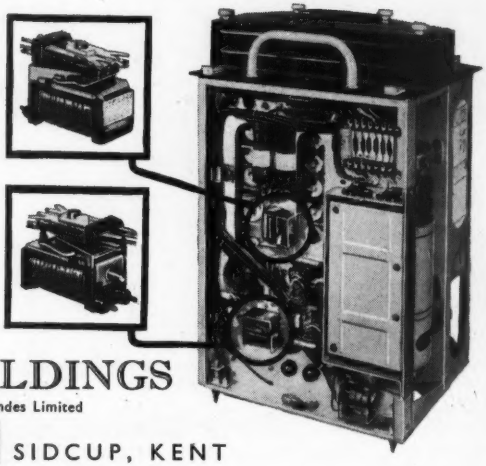

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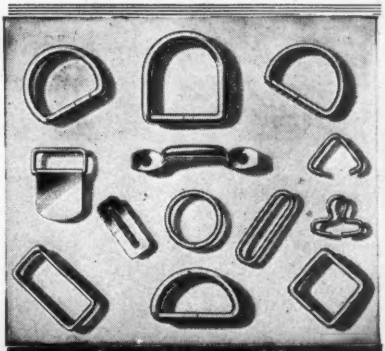

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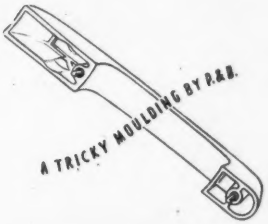

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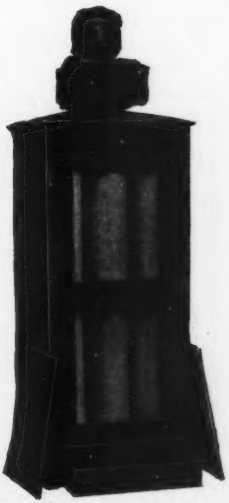

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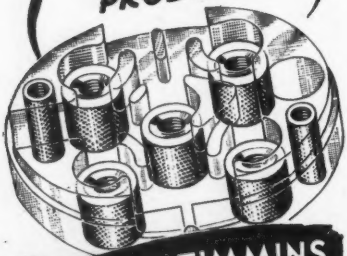

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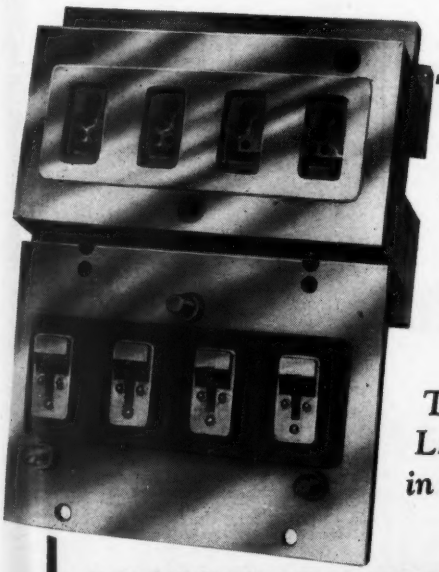

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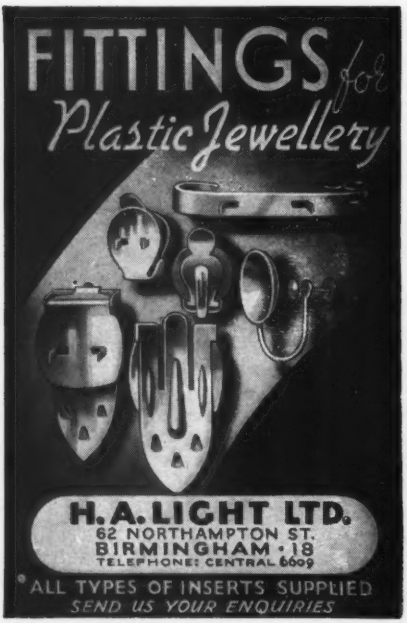

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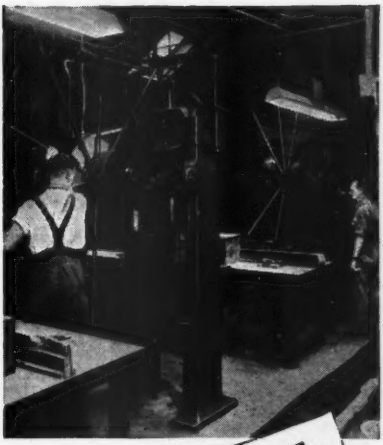

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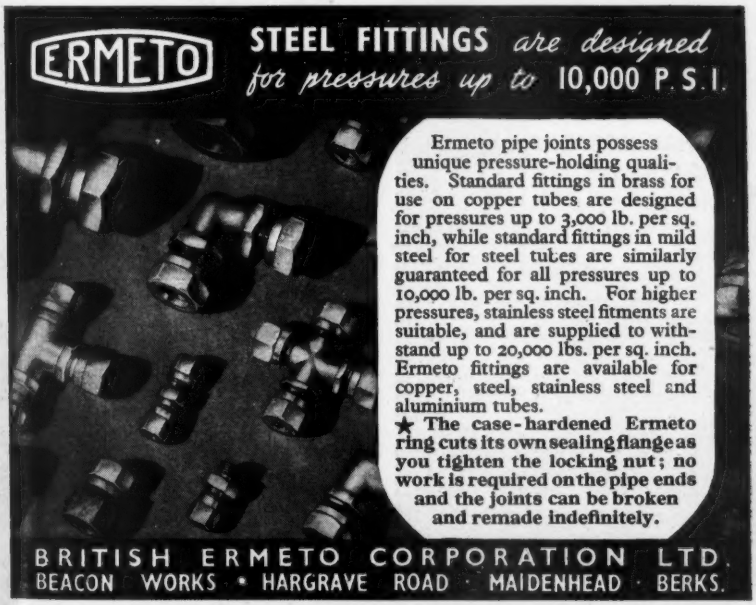
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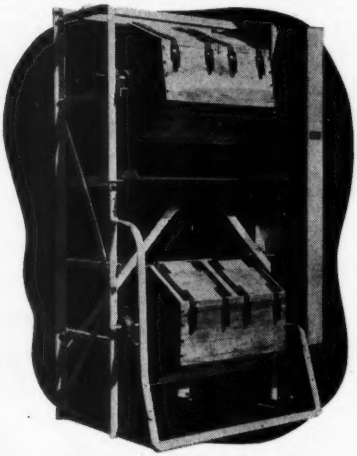

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D. N. Hunter, Plastics Technologist and Consultant, 37 Hensall Terrace, Carlinghow, Batley, Yorkshire. Research, development, analysis, advice, assistance. 135-254

Agents required for Scotland, N. Ireland, S. Wales and S.E. Coast to handle additional lines, sale of plastic moulding powders direct to moulders. Applicants must have knowledge of plastic industry. Apply, F.W., Box 4770, care of "Plastics." 134-48

Agencies Wanted

Wanted, sole agencies for factor lines, all territories. Rose, Russell Street, Bingley, Yorks. 134-x1321

London firm with long technical and sales experience in plastics open to represent efficient trade moulders (compression and injection) for London area. Box 4816, care of "Plastics." 134-42

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Southampton. Plastics goods manufacture, good connections with retailers, turnover £20-£25 per week, workshop rent £1 per week, milling machine, jig-saw, polisher, etc. Goodwill, plant, £580; stock, £250 approximately. National Business Agency, Ltd., 39 King William Street, London, E.C.4. Mansion House 4922. 134-x1941

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Design Your Problem? Our Business! 16 years' experience of mould design and manufacture offered to our clients. Good deliveries, moderate charges. We can arrange manufacture, too, if desired. M.M. Designs, 136 Spencer Place, Leeds, 7. 135-309

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Alternators, Diesel sets, electric motors, switch gear, transmission equipment, fluorescent lighting and industrial fittings ex stock. Keen prices. Contact G. L. Murphy, Ltd., Menston, near Leeds. zzz-210

Bandsawing machines (16-in. throat, 9-in. depth cut); spindle moulders (25-in sq. table); circular saw benches (16 ins. and 18 ins.). Early deliveries. Curtis Engineering Co., 119-121 York Road, London, S.W.11. 184-6439

Electric motors. Send us your inquiries. Over 250 motors always in stock. Rossini Import and Export, Ltd., Copthall House, Copthall Avenue, London, E.C.2. Monarch 8345. 135-x9969

750-ton upstroke hydraulic bobbing press, 22 ins. by 18 ins. between pillars, 11-in. stroke, complete with electric motor, starter, pumps, intensifier, control valves, gauge tanks, pipes, etc. Excellent condition. Can be seen working by appointment. Apply L. Lipton, Phoenix Works, Lamprell Street, Bow, E.3. Adv 3345, 2442. 135-247

Machinery, Tools and Plant (contd.)

Two upstroke presses, "Finney," 8-in. diameter main rams, 9-in. stroke, working pressure 1 ton per sq. in., fitted with pull-back rams and semi-automatic extraction gear, 14-in. sq. platen area. Daylight 28-in. maximum adjustable, good condition, used on oil.
Apply Victor H. Iddon, Ltd., Wythenshawe, Manchester. 134-249

Two new four-spindle lens-polishing machines, motorized, suitable for plastics, or other circular polishing process. Full details from A. W. Barker and Co., Ltd., Colnbrook, Slough. Phone, Colnbrook 140. 135-252

Shaw hydraulic accumulator, 120 tons cast iron weight loaded type with three throw pumps, mot A.C. 415/3/50, latest design, as new.
Two Shaw hydraulic presses, 60 tons, four columns, platens 3 ft. 6 ins. by 4 ft., daylight 6 ft. 6 ins., as new.
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Plastic Injection, machine capacity, 1 to 2 oz.
Christy and Norris.
Twin compressor, water-cooled V-belt drive, 25 h.p., A.C., starter, air receiver, water tank, 100 lb. pressure, 30 to 40 cubic ft. per min., compressor, Broome and Wade, perfect condition.
High-speed drilling machine, precision, self-contained, six speeds.
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For Sale, two off hydraulic, three throw ram pumps, complete with motors and starters, standard supply, in good condition. Also one off tow-type Lister pneumatic tyre, as new. Further particulars apply Box 4601, care of "Plastics." 134-29

For Sale, two pedestal finishing and sanding machines, 6 ins. by 36 ins., band motorized, £30 each. Box 4603, care of "Plastics." 134-26

Shipton Moulding Press for immediate disposal, little used, in excellent condition. Box 4606, care of "Plastics." 134-24

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Unjacketed cast-iron vertical mixer, 3-ft. diameter by 2-ft. deep, with cover, 4-in. diameter bottom side outlet, 3 paddle arms with bevel gear, pulley drive. Below.
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Increase sales appeal by colour! Hand colouring on any plastic smallwares expertly carried out with taste. Long runs only accepted. Send your samples for quotations to Proda (London), Ltd., 17 Bishop's Bridge Road, London, W.2. 139-4972

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Capacity required for manufacture of plastic mouldings, 3½-in. diameter nameplate discs. J. A. Brooke and Co., Longridge, Pyrford, Surrey. 134-x1940

Dohm, Ltd., pulverize raw materials everywhere. 167 Victoria Street, London, S.W.1. zzz-224

Calendering. Capacity available as a result of additional plant installation. High-grade work from long experience. Own or customers' materials. Laboratory service if required. Write Box 4508, care of "Plastics." 136-310

Injection moulding specialists have moulding capacity up to 4 oz. Consultants on all injection moulding problems. Please send inquiries to Box 9761, care of "Plastics." 134-33

Completion of export contracts enables us to undertake all classes of moulding. Immediate production if moulds available. Norton Plastics, Ltd., Ilkeston, Derbyshire. 134-22

Capacity available for small industrial thermosetting mouldings to close limits; own fully equipped toolroom. Box 4573, care of "Plastics." 135-x2064

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Wanted, blanks in perspex, casein or similar material; ½-in. to 1¾-in. diameter, ¼-in. to ⅜-in. thick. Quote lowest price for quantities. Material supplied if required. Box 4602, care of "Plastics." 134-28

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Phone, Victoria 9182-3. 138-256

Large quantities cellulose acetate injection, first-quality virgin material in several colours, for sale; also quantity of crinothene in standard rolls, pastel shades. Norton Plastics, Ltd., Ilkeston, Derbyshire. 134-21

Moulding powder for sale, black phenol, proprietary brands. Norton Plastics, Ltd., Ilkeston, Derbyshire. 134-20

39 tons walnut-shell powder for immediate disposal, preferably in one lot. Box 4511, care of "Plastics." 134-12

Perspex sheeting, surplus to requirements for disposal: 35 sheets 1/16-in., 45 sheets 3/32-in. G. Nissel and Co., Ltd., Siddons Lane, Baker Street, N.W.1. Ambassador 3308. 134-x1938

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2,000 SHEETS CRYSTAL-CLEAR 40-THOU. ACETATE.
Size 56 ins. by 25 ins.
Weight per sheet 2 lb. 14 ozs.
LOW PRICE FOR COMPLETE CLEARANCE.
ALSO 1 TON 3-MM.
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P.V.C. strippings from cables, thoroughly cleaned, black, brown, red, yellow, blue, etc. Segregated. Large quantities, 1s. lb.
John Walton and Co. (Castleside), Ltd., Metalex Works, Great Cambridge Road, Enfield. Phone. Enfield 3425. zzz-219

Raw Material Available and Wanted (contd.)

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A new moulding plastic for repetition casting plaster-of-paris, cement, resins, etc.; finest detail. Tough, highly flexible; can be remelted and used repeatedly. Send for full details about "Vinamold." Vinyl Products, Ltd., Carshalton, Surrey. 134-11

Materials for sale. Cellulose acetate moulding powder, virgin and reground. Sheets various colours and thicknesses. Polystyrene moulding powder, virgin, various colours. P.F. black moulding powder. P.V.C. sheeting. Box 4751, care of "Plastics." 134-9

Polystyrene in light blue (virgin) wanted against cash payment, good price paid, or would exchange for other colours. Write Box 4755, care of "Plastics." 134-7

Polythene powder (white) for disposal, well below maker's price, sample sent upon request. Box 4272, care of "Plastics." 135-246

Always large stocks of

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rods, tubes and sheets.

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sheets up to 1-in. thick.

CELLULOSE ACETATE.

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Phone, Clerkenwell 4686. 138-250

An entirely new embossed sheeting, ideal for upholstery and fancy leather goods, unbacked, extremely strong, tough and pliable, excellent graining, antique, morocco, calf, pigskin, etc., all standard colours, 48-in. width. Almex, Ltd., Exchange Buildings, Stephenson Place, Birmingham, 2. Midland 0682.

Cuprex, Ltd., 120 Moorgate, London, E.C.2. Metro 9641. zzz-223

A lighting fittings manufacturer seeks an alternative plastic material to those more in current use. Forward details to Box 4298, care of "Plastics." 134-255

Ebonite and bakelite always in stock. Phone, Archway 3654, A. E. Goodeve, Ltd., 188a Seven Sisters Road, London, N.7. 139-4965

Scrap. Why not let a well-established firm quote you for cellulose acetate, polystyrene, P.V.C. cuttings and other thermoplastic off-cuts and scrap? Having best use for these materials, highest prices can be paid. Quotations on receipt of representative samples to M. H. Grist (Plastics), Ltd., 82-84 Brighton Road, Surbiton, Surrey. Phone, Elmbridge 4214. zzz-457

Wanted, plastic waste and plastic piece goods. Send particulars, stating quantity and price. Box 2382, care of "Plastics." zzz-468

Regular supplies of imported celluloid in sheets, tubes and rods. H. J. Alter, 51 Seymour Street, W.1. Phone, Paddington 3137. zzz-221

We have all types of thermo-plastic scrap, reconditioned moulding powders and virgin moulding powders available, and shall be pleased to receive your inquiries for samples and quotations. Please state exact requirements to Box 4757, care of "Plastics." 134-6

Thermo-plastic scrap urgently required, in particular polystyrene and polythene. Send samples and price required to Box 4756, care of "Plastics." 134-5

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Polystyrene scrap.

Firms having this material for disposal please contact Newchem, Ltd., London Road, Poynton, Cheshire. 134-3

Raw Material Available and Wanted (contd.)

For sale, supplies of butyl stearate, butyl oleate, butyl laurate, also limited amount of tri-oresyl phosphate. All inquiries in the first instance to Box 4577, care of "Plastics." 135-x2051

3,000 sheets clear cellulose acetate, 56 ins. by 25 ins. by .010 in., new material and interleaved at 4s. per sheet. Inspection in London, or samples on request. Kent Insulations, Ltd., Great Thrift, Petts Wood, Kent. Orpington 5238. 134-x2194

Perspex. For sale, large quantity clear and pastel shades, 1-16 in. to 3-16 in. thickness. Box 4604, care of "Plastics." 134-27

Flat Perspex sheets, clear, coloured, 54 ins. by 48 ins., or cut sizes. Corrugated Perspex roof lights. Aluminium and plastic sheeting. Alloy mouldings Henry Moat and Son, Ltd., Atom Works, Newcastle. 134-1

Buna-plast, a blending of synthetic rubber and P.V.C. specially processed for manufacturing leather substitute; this material is far superior to plasticized P.V.C., inquiries welcomed. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-230

P.V.C. calendering compound in a range of opaque colours. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-229

Polystyrene moulding scrap urgently required, state amount available and send small sample. Box 3185, care of "Plastics." zzz-228

1st quality virgin cellulose acetate moulding powder available. Box 3184, care of "Plastics." zzz-227

Polythene moulding powder (reconstituted) in black natural and a variety of colours. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-226

Metal powders and oxides. Quotations and samples on application. Dohm, Ltd., 167 Victoria Street, London, S.W.1. zzz-225

Polystyrene scrap or surplus stocks of virgin material wanted. John P. Steel, Dept. 8, Bingley, Yorks. Phone 1066 (four lines). 137-311

Wanted Perspex scrap, any size, colour or shape. Reply, giving quantities, prices, etc., to John P. Steel, Dept 8, Bingley, Yorks. Phone 1066 (four lines). 135-306

The following material is available from stock:—

British origin.—Cellulose acetate: 1,120 lb. black, reground; 2,240 lb. tortoise shell.

American origin.—Cellulose acetate: 4,480 lb. black, reground; 500 lb. rust, reground; 500 lb. red, reground; 500 lb. blue, reground; 500 lb. green, reground.

Apply, Whitehouse Industries, Ltd., Great North Road, Ferrybridge, Yorks. 134-38

For sale. 5/16-in. thick, clear Perspex, sheet size, chiefly 36 ins. by 36 ins.

Apply, Ashdowns, Ltd., Eccleston Works, St. Helens, Lancs. 134-37

Polystyrene moulding powder, finest virgin material for disposal. Delivery immediate ex-stock, 4½ tons, colours being clear, white, green, red, black, royal blue. Keen price to clear. Box 4263, care of "Plastics." 134-32

Quantity of clean acrylic flash surplus in pale cream shades, easily reduced or coloured. Samples. Offers required. Box 4819, care of "Plastics." 134-39

Virgin polystyrene moulding powder in translucent colours for sale; red, green, amber and blue. Reasonable price. Write Box 4818, care of "Plastics." 134-40

Perspex wanted, all thicknesses, clear and coloured. Advertiser will take full sheets in large quantities. Prices must be well below I.C.I. Box 4259, care of "Plastics." 134-44

Perspex. For sale, about 5 tons clean, clear scrap and small offcuts. John Castle and Co., Ltd., 18a Newport Street, Lambeth, S.E.11. 134-46

P.V.C. For sale, clean sheeting cuttings and cable strippings. John Castle and Co., Ltd., 18a Newport Street, Lambeth, S.E.11. 134-45

PERSPEX.

Official stockist offer clear and pastel shades in standard sheets or cut to specific requirements. Also

MOULDED SHAPES

to special requirements of all types in Perspex.

SYNTHENA, LTD.,

AKED STREET, VICAR LANE,

BRADFORD.

134-10

Raw Material Available and Wanted (contd.)

D. H. Ridout and Son, Ltd. Reg. Office, 12 Stedman Road, Southbourne, Bournemouth. Phone 505. Official stockists for I.C.I. acrylic Perspex, clear and coloured, and Crinothene sheeting in all shades.
New Perspex sheets, 48 ins. by 36 ins. by 1-16 in. to 3-16 in., from 45s. per sheet. Other sizes pro rata.
Scrap crystal and amber Perspex from 1s. 3d. to 2s. per lb., according to gauge and quantity required.
Acetate and celluloid transparent sheeting from 1s. 6d. per lb.
Coloured transparent and opaque celluloid and acetate sheeting from .007 in. to .120 in., from 3s. 9d. per lb. Crystal acetate, 2, 3, 4, 5 and 6 mm., from 5s. 6d. per lb. Full-size sheets.
Large stock of various plastic materials suitable for lamp shade, toy makers and upholsterers, etc.
Samples and stock list on request. 134-50

SITUATIONS VACANT

None of the vacancies in these columns relates to a man between the ages of 18 and 50, inclusive, or a woman between the ages of 18 and 40, inclusive, unless he or she is excepted from the provisions of the Control of Engagement Order, 1947, or the vacancy is for employment excepted from the provisions of that Order.

Physicist required for a new research laboratory in Essex dealing with plastics, powder metallurgy, recording and electronics. Possibility of a small flat being available in Essex near the laboratory. Age 25-35. Applicants should give full details of experience and salary required, etc., to Box 4505, care of "Plastics." 134-16

Representatives required by Manchester makers of plastic and rubber-proofed piece goods for rainwear, leathergoods, upholstery, furnishing, fancy goods, etc., for the following areas—Midlands and West of England, Scotland and North of England, Lancashire and Yorkshire including Manchester area. Applications invited from agents well introduced with the wholesale houses and making-up trades in their areas and who can provide first-class references. Write Box 4509, care of "Plastics." 134-13

Chemist required for a research laboratory in Essex dealing in plastics and powder metallurgy. Possibility of a flat in the country being available. Age 25-35. Applicants should give full details of experience and salary required, etc., to Box 4506, care of "Plastics." 134-17

Estimator. Qualified and experienced estimator wanted by factory in London area engaged on moulding and fabrication. Applicants must have previous experience in plastics industry. Write fully detailing qualifications, age and salary required to Managing Director, Box 4507, care of "Plastics." 134-18

Draughtsman. Vacancy for Section Leader for compression and injection mould designer-draughtsman, moulding-shop experience essential, and to assist in development and design of new products at new modern factory, Lancashire area. Write stating full details of experience, salary required. Box 4607, care of "Plastics." 134-23

Chemist for reseach on plastics required by well-known manufacturers near London. Experience in organic and physical chemistry desirable but not essential. Fresh graduates acceptable but must have good degrees, Ph.D. standard preferred. Permanent and progressive position with good salary and prospects. Send full particulars of education, experience, age and salary required in strict confidence. Box 4605, care of "Plastics." 134-25

Plastic mould designer required, to take charge of drawing office. Must have tool estimating experience. Glasgow area. Box 4600, care of "Plastics." 134-30

Young mechanical engineer to be trained as assistant to the technical manager required by North-west plywood factory. State qualifications, previous experience and salary expected. Box 4752, care of "Plastics." 136-307

Works foreman required with technical knowledge and experience of injection moulding. Apply with full details of previous experience, salary required and age to Box 4471, care of "Plastics." 134-x1625

Foreman with extensive experience in injection moulding and finishing operations for our new factory required immediately. Apply, giving fullest particulars, Commercial Plastics, Ltd., Wallsend-on-Tyne. 134-251

Assistant chemist wanted in the Liverpool area. Inter B.Sc. or preferably recently qualified B.Sc. or A.R.I.C. Experience with synthetic resins or moulding of thermosetting plastics an advantage. Salary in accordance with qualifications. Box 4821, care of "Plastics." 134-49

Situations Vacant (contd.)

Chemist, plastic and paints, required by large firm in Birmingham. Excellent opportunity for young person with ability and initiative. State age, experience, qualifications and salary. Box 4749, care of "Plastics." 134-47

Engineer with first-class knowledge of injection moulding and pressure diecasting required to take charge of new section of existing South Wales factory. Experience on mould design and maintenance necessary. Permanent position with excellent prospects. Apply stating full details, salary required. Box 4815, care of "Plastics." 134-43

SITUATIONS WANTED

Moulding shop foreman, 19 years' practical experience compression and injection, seeks situation, home or abroad, excellent references. Box 4652, care of "Plastics." 135-x2373

Well-educated young man seeks appointment as assistant sales manager or equivalent. Experienced in sales office organization and technical sales representation, specializing in polythene. Box 4373, care of "Plastics." 134-x1243

Engraver diesinker hobs and moulds (including button and dental) desires change. Box 4741, care of "Plastics." 134-x2670

Perspex and compression moulder, with experience moulding-shop administration, seeks position in or near London. Box 4814, care of "Plastics." 134-x2840

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Factory time recorders. Service rental. Phone, Hop 2239. Time Recorder Supply and Maintenance Co., 157-159 Borough High Street, S.E.1. 137-3686

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Monomarks. Permanent London address. Letters redirected, 5s p.a. Write, Monomarks, BCM/MONO76, W.C.1. 134-5313

Plastic cement for use with Perspex Acrylic sheets, Grade I, available in large or small quantities, clear and coloured. Trade inquiries from Evolite Plastics, Ltd., 325 Latimer Road, London, W.10. Phone, Lad 1879. 1138-04011

Engraved name plates, scales dials, etc., supplied. Tickets and Co., Box 2, Silver Street, Leicester. 141-5699

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Huts, Nissen-type, 24 ft. span and 16 ft. span, any length; also other industrial buildings, suitable for workshops, stores, garages, canteens, site office, club halls, etc., no acquisition licence required. Write phone or call for details. J. Thorn and Sons, Ltd., Box 138, Brampton Road, Bexleyheath, Kent. Phone, Bexleyheath 305. zzz-204

New Plastic Devices for education, office, stores, games, pools, advertising. Novel containers for sample products, confectionery, etc. Manufacture and distribution offered progressive firm. Write Box 4537, care of "Plastics." 135-x1939

Short Run Bakelite Mouldings. No need to think in tens of thousands for your special bakelite moulding. We make special knobs or other small parts to your own design, in quantities of 50 to 1,000, with no mould costs. Quick deliveries. Domestilux, 14 Bute Street, Luton, Beds 134-x690

Photography by Behr will show your products at their best. Ask for illustrated list. 44 Temple Fortune Lane, London, N.W.11. Speedwell 5298. 145-312

Screws! Screws! Screws! We have immense quantities of all types of BA screw available for immediate disposal. Box 4750, care of "Plastics." 135-308

The Following Registered Trade Marks were assigned on February 11, 1948, by British Moulded Plastics, Ltd., of Avenue Works, Walthamstow Avenue, London, E.7, to De La Rue Insulation, Ltd., of Imperial House, 84-86 Regent Street, London, W.1, without the goodwill of the business in which they were then in use.
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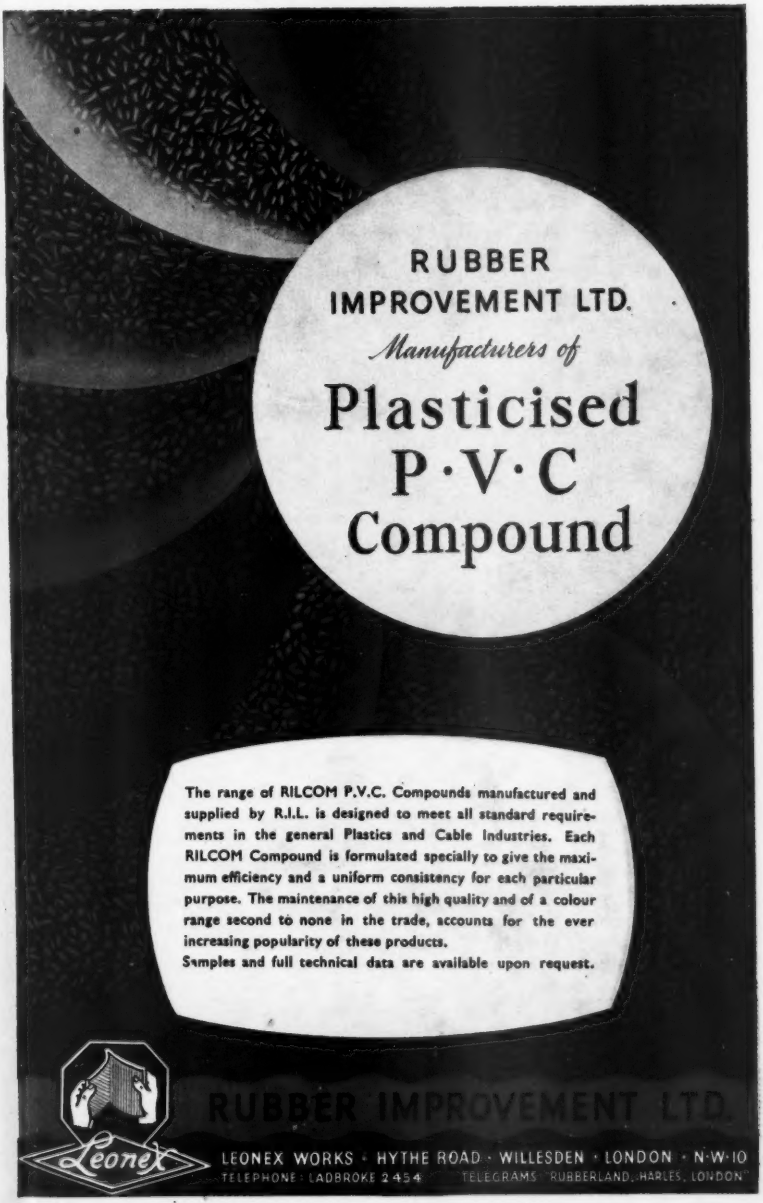
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Plastics

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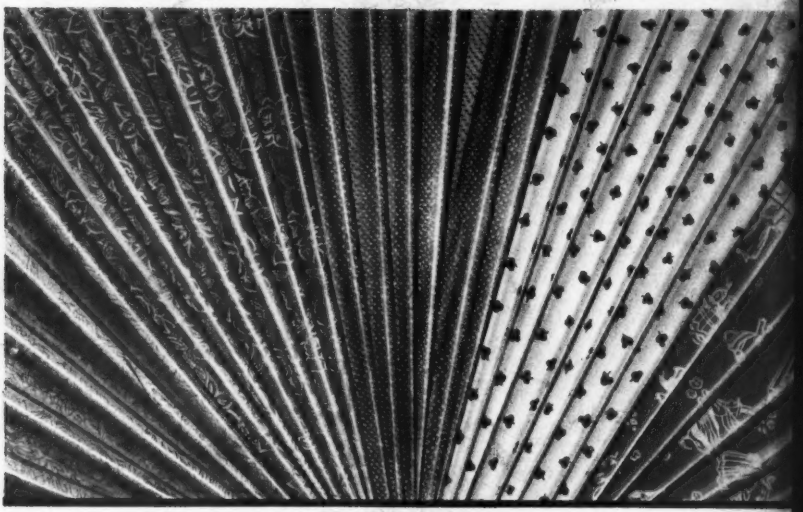

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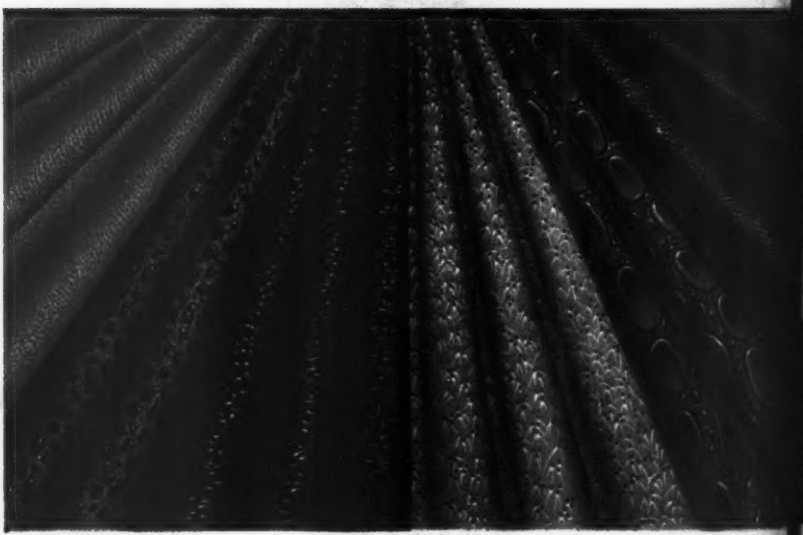

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